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SEP 15 1998

Colorado Department of Public Health and Environment

SEP 15 1998

98-DOE-03807

Dear Stakeholder

Enclosed is the 1998 Rocky Flats Cleanup Agreement (RFCA) Annual Review, including a review of the Radioactive Soil Action Levels (RSALs) Pursuant to RFCA paragraph 5, the Parties have committed to an annual review which assesses new or revised statutes and regulations as well as written policy and guidance to determine if any updates to RFCA are necessary The 1998 RFCA review, including the review of RSALs, does not warrant any changes or updates to the document

If you have any questions please feel free to contact any one of us

Sincerely,

/s/ /s/ /s/

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1998 Rocky Flats Cleanup Agreement (RFCA)
Annual Review
Radionuclide Soil Action Levels (RSAL) Review Summary

The RFCA was signed by the DOE, EPA and CDPHE on July 19, 1996 The RFCA Parties have committed to annually reviewing the agreement to determine if any revisions are necessary In addition to the annual review prescribed in RFCA Paragraph 5, the agencies committed to conducting an internal annual review of the RSALs

A working group composed of members from the EPA, CDPHE, DOE, and the Kaiser-Hill Team was convened to review any new information concerning the RSALs in compliance with RFCA requirements This RSAL Working Group (RWG) identified and reviewed eleven new or revised statutes, regulations, written policy and/or guidance that may impact the RSALs This year's review focused on four primary areas (1) regulatory basis for setting RSALs, (2) computer models, (3) exposure parameters, and (4) input parameters at other DOE Sites This summary provides a general overview of what was reviewed in each area

Although some of the information gathered in this review will ultimately impact the RSALs, the Working Group recommended that it was not appropriate to recalculate the RSALs at this time The RFCA Project Coordinators agreed with the recommendation for the following reasons

- The regulatory basis of the RSALs needs to be analyzed once the NRC draft guidance on "Demonstrating Compliance with the Radiological Criteria for License Termination (LICTERM)" is finalized,
- The RSAL Oversight Independent Review needs to be completed,
- No major ER projects are planned for FY 99 that will focus on radionuclides,
- The Actinide Migration Study may provide applicable information within the next year,
- More time is required to analyze the cleanup levels at other sites

The following is a basic description of the major elements of the review

Regulatory Basis and Computer Model

The RSALs are currently based on the computer model "RESRAD," Version 5 61 The RESRAD computer code was selected for use in deriving soil action levels because it met all applicable modeling requirements The RWG recommends that the latest versions of the RESRAD computer code and the DandD computer code be assessed before recalculating RSALs. The DandD computer code is an integral part of the NRCs LICTERM regulatory guide. When the LICTERM regulatory guide is finalized, the RWG recommended that an analysis be performed to see if RESRAD or DandD should be used to recalculate RSALs.

Exposure Parameters:

The RSALs are currently based on the hypothetical residential, office worker, and open space exposure scenarios. All exposure scenarios are still applicable for deriving RSALs The hypothetical residential exposure scenario is still valid due to the regulatory requirements in EPA's draft 40CFR196, "Radiation Site Cleanup Regulations " The office worker and open space exposure scenarios are still valid under RFCA and the Rocky Flats Vision The RWG has proposed a number of changes to the exposure parameters

associated with these exposure scenarios For example, based on new Jefferson County Open Space statistics, the assumed number of future open space visits to Rocky Flats was changed to from 25 to 100 per year However, the RWG does not recommend that the interim RSALs be recalculated at this time due to the pending regulatory analysis discussed above

Other Site Cleanup Levels

The RWG identified the Nevada Test Site (Tonopah Test Range) and the State of Washington (Hanford) as two other sites that had derived interim radionuclide cleanup standards for plutonium, americium and/or uranium using the RESRAD computer code The RWG did not have the necessary time to analyze these other levels Over the course of the next year the radionuclide cleanup levels used at these other sites will be reviewed in more detail in order to understand how their standards are derived and to determine if there is any information that may affect the RSALs

1998 Rocky Flats Cleanup Agreement
Annual Review
September 1998

1.0 BACKGROUND

The Rocky Flats Cleanup Agreement (RFCA or Agreement) was signed by the Department of Energy (DOE), the Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE) on July 19, 1996 The RFCA Parties have committed to review the agreement to determine if any revisions are necessary RFCA paragraph 5 states

The Parties shall conduct an annual review of all applicable new and revised statutes and regulations and written policy and guidance to determine if an amendment pursuant to Part 19 (Amendment of Agreement) is necessary

In addition to the annual review prescribed in RFCA paragraph 5, the agencies committed to conducting an internal annual review of the radionuclide soil action levels (RSALs). Questions to be addressed on an annual basis include

1 Is there new scientific information available that would impact the interim action levels?

2 Has a national soil action level been promulgated within the year? If yes, the parties commit to revisit the Rocky Flats interim action levels

3 How were the interim action levels applied to the site over the course of the year?

4 Have the remedies been effective?

(See, Responsiveness Summary for Soil Action Levels released on November 6, 1996)

This report is a summary of the Parties' 1998 regulatory/radionuclide soil action levels annual review

1.1 What the Parties reviewed this year

The 1998 Regulatory/Radionuclide Soil Action Level Annual Review covers the period from July 1, 1997 through July 1, 1998 The following environmental laws and associated regulations, written policy, and guidance were reviewed

Comprehensive Environmental Response, Compensation, and Liability Act;
Resource Conservation and Recovery Act/Colorado Hazardous Waste Act;
Toxic Substances Control Act;
Clean Water Act,
Clean Air Act;
National Environmental Policy Act,
Endangered Species Act, and
Radiation Related Document Review (See Section 6 0)

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In addition to the above environmental laws and the radionuclide soil action levels, the Action Levels and Standards Framework for Surface Water, Ground Water, and Soils, the Preliminary Programmatic Remediation Goals (PPRGs), and the Implementation Guidance Document (IGD) were reviewed Summaries of these reviews are described below

1.2 What the Parties did not review as part of the annual review

Pursuant to RFCA paragraph 281, DOE developed, in consultation with CDPHE and EPA, a revised Community Relations Plan entitled "Rocky Flats Site-wide Integrated Public Involvement Plan" (Plan) The Plan was completed in March 1998, and is available in the Rocky Flats Public Reading Rooms. RFCA requires an annual review of this document, however, due to its original completion date, it was not reviewed as part of the 1998 annual review It will be reviewed as part of the 1999 annual review process

The Integrated Monitoring Plan (IMP) is being reviewed for FY98-99 An IMP Working Group was formed including members from DOE and its contractors, EPA, CDPHE, and stakeholders The final FY98-99 IMP is scheduled for completion by August 6, 1998

DOE reviews and updates, as required the Environmental Restoration Ranking (RFCA paragraph 79), the Administrative Record (RFCA paragraph 284), the summary level baseline (RFCA paragraph 141), and the Historical Release Report (RFCA paragraph 119(l)) on an annual basis These reviews are scheduled for completion by September 30, 1998

The Integrated Water Management Plan (IWMP) is also reviewed annually, the Rocky Flats Water Working Group will conduct the next review of the IWMP

For more information on any of the above documents, contact either a RFCA Project Coordinator or an Agency community relations representative after September 30, 1998

1.3 Public Participation

Stakeholders were invited to submit any new information relevant to the RFCA or soil action levels for this review in a letter, dated April 16, 1998. Written comments were accepted by the agencies through June 16, 1998. No comments were submitted

2.0 ENVIRONMENTAL STATUTES

As stated above, all major environmental laws, regulations, written policy, and guidance were reviewed. If there was a change to an environmental law, regulation, written policy or guidance, the Kaiser-Hill Company, L. L C (Kaiser-Hill) Team reviewed whether the change had been implemented at the site and whether the change impacted RFCA. This review was completed by the Kaiser-Hill Team and reviewed by the IGD working group

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2.1 Comprehensive Environmental Response, Compensation, and Liability Act

While the action has been pending for several years, the reauthorization of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) did not occur in the past year Congressional efforts for reauthorization continue in 1998 EPA has not amended or promulgated new regulations on the National Oil and Hazardous Substances Pollution Contingency Plan, however, EPA has issued several new polices and guidance documents that may be used at Superfund sites Table 1 is a partial list of EPA's new policy and guidance documents that were issued since July 1, 1997 that may be relevant to RFETS

EPA proposed modifications to 40 CFR parts 355 and 370, which are the regulations implementing sections 302, 303, 304, 311, and 312 of the Emergency Planning and Community Right-To-Know Act The proposed changes are intended to reduce reporting burdens and to set new reporting thresholds for some additional hazardous chemicals under sections 311 and 312. (63 FR 31268). Proposed regulatory revisions have not been finalized at this time and the RFCA Parties will continue to monitor regulatory activity associated with this effort

2.2 Resource Conservation and Recovery Act/Colorado Hazardous Waste Act

There was one amendment and two final rules impacting the Resource Conservation and Recovery Act/Colorado Hazardous Waste Act (RCRA/CHWA) regulations over the past year

1 Used oil management requirements,

2 Organic air emissions monitoring and reporting requirements (Subpart cc), and

3 Land Disposal Restrictions (LDR) requirements (Phase IV, parts 1 and 2)

The Kaiser-Hill Team has implemented changes to the RFETS used oil management procedures due to amendments in the used oil management regulations (6 CCR 1007-3) A final rule to the organic air emissions program was determined to be not applicable to RFETS due to exemptions within the rule for radioactive waste systems

The Kaiser-Hill Team has determined that there are two major changes resulting from the final Phase IV LDR rule issued on May 26, 1998, (63 FR 28556) that impact the site First, certain characteristically hazardous wastes (D004-D011), which were not previously subject to the LDR requirement to meet the Universal Treatment Standards (UTS) for underlying hazardous constituents, are now subject to those requirements. This requirement may require additional sampling and analysis for some potentially high volume wastes, and it may require additional treatment if an underlying hazardous constituent exists in concentrations above the UTS. RFETS characterization procedures have been modified to incorporate the changes. For mixed wastes, these requirements do not become effective until May 26, 2000

Since the treatment standards for D004-D011 mixed hazardous waste will be subject to UTS for underlying hazardous constituents beginning May 26, 2000, RFCA milestones

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involving the treatment and/or disposal of large volume wastes may need to be reviewed to determine if the timing of such milestones coincides with the effective date of this new standard There may be considerable costs associated with meeting the new standard when it becomes effective for mixed hazardous wastes

Second, the LDR standards for hazardous waste soils have been modified by the final Phase IV LDR rule The modification requires the treatment of soils to either a 90% reduction of, or ten times the UTS, for the hazardous constituents contained in the soils This modification has the potential to impact RFCA projects For example, the reduced treatment standard for hazardous waste soil may potentially lead to an economic decision to land dispose soils which contain hazardous waste in accordance with RCRA rather than to a RFCA put-back level

CPDHE proposed a Soil Remediation Objectives Policy Document in December 1997 The document describes a method for developing soil remediation objectives for making site-specific remedial action decisions.

2.3 Toxic Substances Control Act

EPA issued a final rule on the Disposal of Polychlorinated Biphenyls (PCBs) on June 29, 1998, effective on August 28, 1998 (63 FR 35384). The final rule·

1 Promulgates significant amendments affecting the use, manufacture, processing, distribution in commerce, and disposition of PCBs,

2 Specifies additional alternatives for the cleanup and disposal of PCBs,

3 Updates marking, recordkeeping, and reporting requirements, and

4 Provides new rules on

-Disposing of "large volume" PCB remediation waste,
-Determining PCB concentration,
-Self-implementing decontamination,
-Storage of PCBs for reuse, and
-Coordinating PCB disposal approval among various Federal Programs

In anticipation of this final rule, EPA did not produce any new Toxic Substance Control Act (TSCA) PCB guidance during the last year.

There are several highlights of the final rule that may impact RFETS First, the rule introduces more flexibility in PCB management by providing the option to store PCB wastes in existing RCRA-permitted container storage units. Second, the rule provides flexibility on PCB disposal by defining two new waste types: PCB remediation waste and bulk product waste. Decontamination, cleanup and disposal options for these waste types as defined may result in smaller volumes of TSCA waste than would have been generated under the previous TSCA rules Third, the rule codifies new TSCA exemptions and exclusions for PCB/radioactive wastes

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2 4 Clean Water Act

While the action has been pending for several years, the renewal of the Clean Water Act (CWA) did not occur in the past year EPA continued to promulgate regulations under the existing Act, but none of the new regulations were applicable to RFETS activities In State matters, no new regulations were adopted which impact RFETS The next scheduled triennial review of water quality standards applied to RFETS is scheduled for November 1999

2.5 Clean Air Act

EPA continued to promulgate regulations under the existing Act, but the majority are not applicable to RFETS activities Where new regulations were applicable there were no new compliance requirements The Colorado Air Pollution Control Division initiated a review of state air permitting and emission control regulations to identify possible revisions and to address the EPA's Credible Evidence Rule and the Compliance Assurance Monitoring Rule Proposed regulatory revisions have not been finalized at this time The Kaiser-Hill Team and DOE will continue to monitor regulatory activity associated with this effort

2.6 National Environmental Policy Act

No separate National Environmental Policy Act reviews have been required or performed under RFCA pursuant to RFCA paragraph 95

2.7 Endangered Species Act

The U S Fish and Wildlife Service issued a final determination to list the Preble's Meadow Jumping Mouse (PMJM) as a threatened species under the Endangered Species Act on May 13, 1998 (63 FR 26517) This action has required that any outdoor construction, remediation, and monitoring, especially any activities conducted near streams and ponds, are reviewed by the Kaiser-Hill Ecology Group. This requirement has not caused any major changes to the planning or conduct of activities at the site because this site requirement has been implemented since 1994 pursuant to the PMJM Protection Policy and procedures for the Identification and Protection of Threatened, Endangered, and Special-Concern Species. DOE must consult with the U.S. Fish and Wildlife Service (USFWS) on any actions that may affect the mouse. Any contractor or subcontractor to DOE must ensure that DOE is aware of any project that requires DOE to consult with USFWS.

2.8 Radiation Related Document Review

See Section 6.0, Radionuclide Soil Action Levels, below.

2.9 Summary

Based on the review of the environmental statutes and associated regulations, written policy, and guidance, no amendment to RFCA is required at this time. However, changes in the environmental regulations, written policies, and guidance have been

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incorporated into the RFETS Master List of Potential Applicable or Relevant and Appropriate Requirements (IGD Appendix J)

3.0 PRELIMINARY PROGRAMMATIC REMEDIATION GOALS

DOE developed risk-based PPRGs in 1995 to establish initial site-wide cleanup targets for contaminants for each environmental medium The PPRGs are currently used in RFCA Attachment 5, as action levels for the following mediums

- Groundwater Action Levels PPRGs based on the residential groundwater ingestion scenario are used where no Maximum Contaminant Level (MCL) is available from USEPA,

- Surface Soil Action Levels For non-radionuclides, PPRGs are used as action levels for the appropriate land use, e g , industrial use or open space use, and

- Subsurface Soil Action Levels For non-radionuclide inorganics, PPRGs are used as action levels for the appropriate land use, e g., industrial use or open space use

A working group comprised of members from the EPA, CDPHE, DOE, Kaiser-Hill, Rocky Mountain Remediation Services, L. L C. (RMRS) and Safe Sites of Colorado (SSOC) was convened to review and update the PPRGs During the annual review, the RFCA Parties decided to review and maintain only those exposure scenarios and exposure pathways that support the Rocky Flats Vision The RFCA Parties assumed that there is no difference associated with exposure factors for an open space area and a restricted open space area as described in RFCA Attachment 5 In addition, the RFCA Parties decided that a summary description of the PPRGs, how they have been developed, and a summary of the exposure scenarios, would be included as an appendix to the IGD (IGD Appendix P)

3.1 Toxicity Values

For the first step in the PPRG annual review, the RFCA Parties reviewed the toxicity values used in calculating the PPRGs Toxicity values are updated regularly by the EPA Toxicity values were obtained from the latest information contained in the Integrated Risk Information System (IRIS) (April 1998) If values were not available from IRIS, the Health Effects Assessment Summary Tables (HEAST) (1997) annual update was consulted The toxicity values have been updated and reviewed by the RFCA Parties. A table summarizing the toxicity values can be found in IGD Appendix P

3.2 Exposure Scenarios

In the second step in the PPRG annual review, the RFCA Parties reviewed the input parameters to the reasonable maximally exposed receptors for each RFETS exposure scenario. These exposure scenarios are groundwater ingestion for a resident; office worker; and open space For a description of each scenario, see IGD Appendix P The exposure pathway associated with the resident is groundwater ingestion The exposure pathways associated with the office worker and the open space exposure scenarios are soil ingestion, soil inhalation, and external irradiation. The incidental ingestion of surface water is also assessed for the open space exposure scenario.

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3.2.1 Residential Exposure Scenario

For the residential exposure scenario, the RFCA Parties reviewed the groundwater ingestion exposure pathway and recommended no changes to the PPRG other than the updated toxicity values

3.2.2 Office Worker Exposure Scenario

For the office worker soil exposure scenario, the RFCA Parties reviewed the soil dust inhalation, soil ingestion, and external irradiation exposure pathways and recommended changing the workday inhalation rate, plus the toxicity values update The current workday inhalation rate is 6.64 m3/work-day (or, .83 m3/hour) based on a total inhalation rate of 20 m3/day adjusted for an 8-hour workday. The source of this inhalation rate is EPA's OSWER Directive 9285 6-03, "Human Health Evaluation Manual, Supplemental Guidance Standard Default Exposure Factors," dated March 25, 1991 The RFCA Parties recommend changing the workday inhalation rate for this scenario to 1 1 m3/hour based on ICRP 66 (September, 1993), "Human Respiratory Tract Model for Radiological Protection " This value is the average between a male and female office worker

The Particulate Emission Factor (PEF) initially used to calculate PPRGs, 4 63 E+09 m3/kg (0.22 ug/m3), was taken from RAGS, Part B This value was changed to the updated EPA default PEF of 1 32E+09 m3/kg (76 ug/m3), obtained from EPA's Soil Screening Guidance Technical Background Document, Office of Solid Waste and Emergency Response, May, 1996 The new PEF will be used to assess the inhalation pathway for all appropriate exposure pathways

The external irradiation pathway has had an annual exposure factor added that takes into account the fact that an office worker spends only part of the year at the office

The RFCA Parties recommended no changes to the soil ingestion exposure pathway for the office worker exposure scenario

The RFCA Parties have calculated a PPRG for radionuclides in soils for the office worker exposure scenario The RFCA Parties decided to keep this PPRG value in IGD Appendix P for comparison purposes only The action levels and interim cleanup levels in RFCA Attachment 5 for radionuclides in soils are based on radiation dose and are outlined in IGD Appendix L.

3.2.3 Open Space Exposure Scenario

For the open space soil/sediment exposure scenario, the RFCA Parties reviewed the original source of the exposure factors to this scenario. Since EPA has not developed default exposure factors for an open space scenario, the original exposure factors were based on an open space usage survey conducted by Boulder County in 1985. Due to the age of the original source used in developing open space exposure factors, the RFCA Parties contacted Jefferson and Boulder Counties to determine if these counties had more recent data on the use of their open space areas Boulder County conducted a survey in 1995; Jefferson County conducted a survey in 1996 The key exposure

factors that the RFCA Parties were reviewing were number of visits per year, duration of the visit, and the inhalation rate which is based on the mix of activities conducted at the open space areas An analysis of the data from the two surveys showed different results between the two counties

The RFCA Parties reviewed the data from the two surveys and attempted to determine if one county may be more representative of future open space use at RFETS or whether the two data sets could be extrapolated in order to combine the results The RFCA Parties determined that extrapolation was not feasible at this time and that the results of the Jefferson County survey would be more representative of the potential use of open space at Rocky Flats after site closure This determination was based on the fact that RFETS is located in Jefferson County, the proximity of RFETS to residential and industrial/office park areas, and because it is possible that open space users at RFETS would ride mountain bikes, which Boulder County restricts in some Boulder County open space areas

The RFCA Parties recommended a change based on the Jefferson County data for the number of visits per year exposure factor The current number of visits per year used in the PPRG calculation is 25 visits per year The RFCA Parties recommended an increase to 100 visits per year One hundred visits per year is equal to the 90th percentile of number of visits per year to open space areas in the Jefferson County survey

The RFCA Parties recommended a change based on the Jefferson County data for the duration of the visit exposure factor The current duration of the visit used in the PPRG calculation is 5 hours per visit The RFCA Parties recommended decreasing the duration of the visit to 2 5 hours per visit Two and a half-hours per visit is based on the 50th percentile of length of time spent in open space areas in the Jefferson County survey

For the inhalation exposure factor, the RFCA Parties reviewed the activities conducted at open space areas in Jefferson County and the percentage of visitors conducting those activities The RFCA Parties recommended the following activity mix based on the survey results

hiking	34.2%
biking	55 6%
jogging	9.1%
other	1.0%

The RFCA Parties recommended an activity level for each activity of either light, moderate, heavy or some combination of the three and calculated a weighted average inhalation rate for the above mix of activities at the specified activity levels of 1 7 m3/hour. This is an increase from the current level of 1.4 m3/hour For a complete discussion of this exposure factor, see IGD Appendix P

The updated EPA default PEF was used to calculate inhalation exposures for open space receptors, as discussed above in the office worker exposure scenario

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Changes to this scenario based on the toxicity values update will also be incorporated The external irradiation pathway has had an annual exposure factor added that takes into account the fact that an open space user spends only part of the year using the open space The RFCA Parties recommended no changes to the soil ingestion exposure pathway for the open space exposure scenario

The RFCA Parties have calculated a PPRG for radionuclides in soils for the open space soil/sediment The RFCA Parties decided to keep these PPRG values in IGD Appendix P for comparison purposes only The action levels and interim cleanup levels in RFCA Attachment 5 for radionuclides in soils are based on radiation dose and are outlined in IGD Appendix L

For the open space surface water exposure scenario, the RFCA Parties recommended no changes to the PPRGs other than the updated toxicity values This exposure scenario is not anticipated to be used at RFETS, consistent with the Rocky Flats Vision, however, the RFCA Parties recommended maintaining the values for comparison purposes to the surface water action levels and standards used in RFCA Attachment 5 The PPRG values are higher than the current surface water action levels and standards

3.3 Status of Recommendations

The RFCA Parties have incorporated all the recommended changes into the PPRG calculations For a complete discussion of the PPRGs see IGD Appendix P

4.0 RFCA ATTACHMENT 5: ACTION LEVELS AND STANDARDS FRAMEWORK FOR SURFACE WATER, GROUND WATER AND SOILS

The ALF was reviewed by a working group comprised of members from EPA, CDPHE, DOE, and Kaiser-Hill to determine if any changes to standards or actions levels were necessary

The working group recommends updating the practical quantitation levels in the ALF surface water table that have been modified since ALF was originally finalized in 1996

ALF uses Maximum Contaminant Levels (MCLs) from the Safe Drinking Water Act (SDWA) as a basis for ground water action levels The ALF working group reviewed the SDWA and determined that there were no changes in the MCL values that would impact ALF. The ALF working group reviewed the proposed PPRG changes and agreed to update the ALF tables as appropriate

During the ALF annual review, CDPHE proposed deleting the ground water action levels and replacing them with the surface water action levels. The proposal is still under consideration and will be further evaluated by the RFCA Parties.

The ALF working group accepted the recommendations of the PPRG working group, discussed above in Section 3 0 These recommendations impact the soil action levels The subsurface soil action levels for organics are still under review

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Prior to any changes to action levels or standards in RFCA Attachment 5, the public will have an opportunity to comment on the proposed changes as required in RFCA paragraph 117

5.0 IGD

A working group comprised of members from the EPA, CDPHE, DOE, Kaiser-Hill, and RMRS was convened to review and update, if necessary, the IGD The IGD working group updated the document Once the document is final, it will be released on-site as a controlled document Stakeholders interested in obtaining a copy of the final IGD should contact either a RFCA Project Coordinator or an Agency community relations representative after September 30, 1998

6.0 RADIONUCLIDE SOIL ACTION LEVELS

A working group comprised of members from the EPA, CDPHE, DOE, Kaiser-Hill and SSOC was convened to review any new information concerning the RSALs This RSAL Working Group (RWG) initially identified any new or revised statutes, regulations, written policy and guidance that may impact the RSALs The RSALs were then reviewed against the requirements within these documents to see if any changes should be made to the RSALs

In addition to the annual review requirements prescribed in RFCA paragraph 5, the RFCA Parties addressed the four questions discussed in the introduction.

As a result of this annual review, the RWG has identified some new scientific information that may warrant a recalculation of the current RSALs For example, Jefferson and Boulder Counties have conducted recent surveys on the actual use of open space within their respective counties The RFCA Parties have evaluated this information and have recommended potential changes to the exposure factors for the open space exposure scenario. In addition, the Actinide Migration Studies (AMS) group is assessing the chemical form of plutonium in the environment at the Site The outcome of the AMS may provide scientific information that may impact the interim RSAL. The RFCA Parties expect to have additional information from the AMS by the end of 1998

An Independent Oversight Review Panel will be independently reviewing the current RSALs starting in Fall 1998. This is anticipated to be an extensive review of the RESRAD model and all the inputs to the model. The RFCA Parties expect to have additional information from the Independent Oversight Review Panel in Spring 1999.

In addition, the RFCA Parties are aware that the NRC promulgated a rule on July 21, 1997, "Radiological Criteria For License Termination." While the rule does not provide a national RSAL, it does provide a basis for determining the extent to which lands and structures must be remediated before decommissioning of a NRC facility is considered complete and the NRC radiological license terminated. The NRC has been preparing extensive guidance on how this rule is to be implemented; however, this guidance has not been finalized in time to be included in this year's review. The RFCA Parties have agreed that the final rule and the accompanying guidance need to be reviewed to determine whether the rule should be applied to the Site, a non-NRC facility; however,

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the RFCA Parties agreed to wait until the guidance was final before undertaking this review

Consequently, due to the scientific information being gathered by the AMS, the CAB independent review and the new regulatory guidance being issued in the near future, the RFCA Parties have decided that the RSALs will not be revised at this time If the RFCA Parties agree that the RSALs need to be revised in the future, then this work will be completed, however, prior to any changed RSALs being incorporated into RFCA Attachment 5, the public will have an opportunity to comment on the proposed changes as required in RFCA paragraph 117

The interim action levels were applied over the course of the year at the Mound Site Volatile organic compounds, americium, and uranium from the Mound Site contaminate the ground water above Tier II ground water action levels in a localized plume discharging to South Walnut Creek. The source of the ground water contamination at the Mound Site has been removed. A passive reactive barrier system of reactive iron was installed to contain the radionuclides and destroy the VOCs prior to release of the water to South Walnut Creek

The interim action levels are being applied at Trench 1 (T1) The source removal at T1 was prompted by the presence of depleted uranium that exceeded Tier I RSAL The contents of the trench will be excavated Soil below the Tier II RSAL will be returned to the excavation. If radionuclide activity levels are between Tier I and Tier II action levels, these soils will be segregated and stockpiled and either disposed of off-site or returned to the trench within a geotextile fabric The T1 project team, including the regulatory agencies, will be consulted prior to returning soil above Tier II RSAL, but below Tier I RSAL, to the excavation

The effectiveness of the reactive barrier for the Mound Site plume and the T1 removal will be verified with monitoring over time The effectiveness of past remedial actions is still being determined by the groundwater monitoring program

6.1 Review of Statutes, Regulations, Policy and Guidance

The following statutes, regulations, policy and guidance were reviewed to assess their impact on the RSALs. A more extensive list of statutes, regulations, policy and guidance were reviewed as part of the annual RFCA review. A brief description of each statute, regulation, policy or guidance is given. This part of the review primarily affected the regulatory basis for deriving the RSALs and the basis for the exposure parameters used to calculate the hypothetical residential exposure scenario, office worker exposure scenario and open space exposure scenario

The RWG recommends retaining the current RSALs derived using EPA's draft 40CFR196, at least temporarily. EPA has withdrawn 40CFR196; however EPA has issued OSWER Directive 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination " The radiation dose limits in this OSWER directive are consistent with the radiation dose limits used to derive the current RSALs With withdrawal of the draft 40CFR196, the RFCA parties need to evaluate the regulatory basis for deriving RSALs. The RFCA parties need to resolve EPA's OSWER guidance calling for a 15 mrem dose standard with NRC's 25 mrem requirement.

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The RWG has identified and recommends that a few assumptions behind the current RSAL exposure parameters may need to be changed in the future The RWG recommends not recalculating the RSALs at this time due to new regulatory guidance being released in the near future The anticipated new regulatory guidance is the NRC's final regulatory guide on "Demonstrating Compliance with the Radiological Criteria for License Termination" (LICTERM) When this regulatory guide is released, the NRC's "Radiological Criteria for License Termination," and implementing guidance, will be reviewed for applicability at RFETS

EPA's draft 40CFR196, "Radiation Site Cleanup Regulations," dated 2/16/96

This regulation sets forth requirements for cleanup levels for sites contaminated with radionuclides and is designed to protect human health and the environment from exposure to ionizing radiation This regulation is currently followed within the RFCA and provides the framework for the derivation of the current RSALs EPA has withdrawn this draft regulation, it is not expected to be reissued in the near future

EPA's OSWER Directive 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," dated 8/22/97

This EPA Directive outlines the radiation risk and radiation dose-based levels that EPA feels are protective of human health This Directive also states that the radiation dose-based cleanup levels promulgated by the NRC are not protective of human health and supports the radiation dose based limits in EPA's draft 40CFR196 The radiation dose limits in this OSWER directive are consistent with the radiation dose limits used to derive the current RSALs

EPA's OSWER Directive 9285.6-03, "Human Health Evaluation Manual, Supplemental Guidance: 'Standard Default Exposure Factors'," dated 3/25/91

This EPA Directive outlines EPA default parameters for standard EPA exposure scenarios and exposure pathways These default parameters are used within the RSALs to the maximum extent possible. Alternative parameters are used in the RSALs when a default parameter from this directive is not available Because this is EPA's primary document for defining exposure parameters for use in risk assessments at CERCLA sites, this is the primary document used to define exposure parameters for deriving RSALs. This document was used to propose revised residential exposure parameters and office worker exposure parameters except for the office worker inhalation rate (See Table 1).

EPA's "Final Exposure Factors Handbook," (EPA/600/P-95/002Fa,b,c), dated 8/97

This handbook summarizes data on human behaviors and characteristics that affect exposure to environmental contaminants. EPA utilizes this data to recommend, along with site specific data, exposure parameters for use in quantifying radiation dose and radiation risk to an individual at sites across the nation. This document was used to propose a revised inhalation rate for the open space exposure scenario (See Table 1)

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DOE Order 5400.5, "Radiation Protection of the Public and the Environment," dated 1/7/93

This DOE Order establishes standards and requirements for operations at DOE facilities with respect to protection of members of the public and the environment against undue risk from radiation This Order outlines the methodologies for calculating radiation dose to the public and the environment as well as delineating radiation dose limits This DOE Order is not used as the basis for deriving RSALs

DOE's proposed 10CFR834, "Radiation Protection of the Public and the Environment," dated 9/13/95

This DOE regulation would codify the requirements in DOE Order 5400.5 The requirements of DOE Order 5400 5 are largely reiterated in this document This regulation is not used as the basis for deriving RSALs

NRC's final 10CFR20, et al., "Radiological Criteria For License Termination," dated 7/21/97

This regulation provides a basis for determining the extent to which lands and structures must be remediated before decommissioning of a NRC facility can be considered complete and the NRC radiological license terminated This regulation is based on cleaning up a NRC facility to a radiation dose-based standard assessed through all exposure pathways This regulation is not used as the basis for deriving RSALs

NRC's draft Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination," dated 2/17/98

This guide supports the requirements in the NRC's "Radiological Criteria for License Termination " This guide describes acceptable radiation dose modeling methods, an acceptable method to conduct a final radiation status survey, an acceptable method to terminate a license under restricted land use conditions and an acceptable method for performing As Low As Reasonably Achievable (ALARA) analyses This guide will be the basis for remediating lands and buildings based on radiation dose at NRC facilities. This regulatory guide is expected to be finalized by August of 1998 This regulatory guide is not used as the basis for deriving RSALs

NRC's draft NUREG-1549, "Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination."

This NUREG contains an overall framework for dose assessment and decision making for site characterization, dose assessments and remedial actions. The framework is designed to be used throughout the decommissioning and license termination process at NRC facilities This document will provide guidance on screening level exposure parameters that are acceptable to the NRC This NUREG is not used as the basis for deriving RSALs

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1996 Jefferson County and 1995 Boulder County Open Space studies

These studies were reviewed to assess the exposure parameters within the open space exposure scenario These studies assessed the behavioral patterns and characteristics of individuals that use the Jefferson County and Boulder County open space areas These studies were used to propose revised open space exposure parameters (See Table 2)

ICRP 66, "Human Respiratory Tract Model for Radiological Protection," dated 9/93

This report describes the model used to calculate radiation dose to the respiratory tract of workers resulting from the intake of airborne radionuclides This report details the anatomy and physiology of the respiratory tract as well as the deposition, clearance and biological effects of inhaled radionuclides. While not new information, the RWG believes it contains pertinent information to the development of the RSALs This document was used to propose a revised inhalation rate for the office worker exposure scenario (See Table 2)

6.2 Review of Exposure Parameters

The RSALs are currently based on the hypothetical residential, office worker, and open space exposure scenarios These exposure scenarios are still applicable for deriving RSALs since these land uses are still valid under RFCA and the Rocky Flats Vision The current and proposed exposure parameters are outlined in Table 1, "Preliminary Draft Exposure parameters for the Radionuclide Soil Action Levels " The RWG does not recommend that the interim RSALs be recalculated at this time due to new current information, however, after evaluation of the NRC rule and guidance, the RWG also recommends the evaluation of the proposed exposure parameters outlined in Table 1 The RWG does not anticipate recommending any changes to the exposure parameters associated with the hypothetical residential exposure scenario due to new current information The RWG recommends that the "Ingestion of Beef/Dairy Products" exposure pathway be assessed for inclusion into the RSAL calculation when the RSALs are further evaluated The RWG recommends that the following documents may need to be reviewed and possibly used to assess the Beef/Dairy Products exposure pathway EPA's Human Health Evaluation Manual, Supplemental Guidance. 'Standard Default Exposure Factor's; EPA's Final Exposure Factors Handbook; EPA's Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions, and the NRC's Review of Parameter Data for the NUREG/CR-5512 Residential Farmer Scenario and Probability Distributions for the D and D Parameter Analysis. Current new information may require a change to the exposure parameters associated with the office worker and open space exposure scenarios. All these proposed changes will be assessed during the evaluation of the implementing guidance from NRCs final LICTERM regulatory guide.

6.3 Review Computer Models

The RSALs are currently based on the computer model "RESRAD," Version 5.61 The RESRAD computer code was selected for use in deriving soil action levels because it met all applicable modeling requirements from DOE, EPA and CDPHE. RESRAD was developed at Argonne National Laboratory for the US Department of Energy so that

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radiation dose to an individual, as well as action levels, could be derived for radioactive material in soils RESRAD models all exposure scenarios and exposure pathways in an integrated manner and assesses daughter products over the 1,000 year modeling period RESRAD is a deterministic computer code that uses discrete values for each exposure parameter for input to the code RESRAD, Version 5 82 is the latest version of RESRAD Table 2, "RESRAD Version History," shows the revisions that have been performed on the RESRAD computer code since Version 5 61 with the upgrades performed on each version

The DandD computer code is a draft computer code being developed by the NRC for use with the final LICTERM regulatory guide The DandD computer code is being developed in order to derive radionuclide cleanup standards, as well as building release limits, for radionuclides on a screening level or site specific basis. DandD is a probabilistic computer code that uses distributions of exposure parameters for input to the code DandD will be the primary computer code used by the NRC to assure compliance with their "Radiological Criteria for License Termination "

The RWG recommends that the latest versions of the RESRAD computer code and the DandD computer code be assessed before recalculating RSALs When the NRCs LICTERM regulatory guide is finalized, an analysis will be performed to see if the RESRAD computer code or the DandD computer code should be used to calculate RSALs at RFETS

6.4 Review Input Parameters Used at Other Sites

In addition to the regulatory and technical reviews discussed above, the RWG identified two other sites during this review that had derived radionuclide cleanup standards for plutonium, americium and/or uranium using the RESRAD computer code The Nevada Test Site (Tonopah Test Range) has derived radionuclide cleanup standards and the State of Washington has derived radionuclide cleanup standards for the Hanford site These radionuclide cleanup standards are documented in the reports Radiological Dose Assessment for Residual Radioactive Material in Soil at the Clean Slate Sites 1, 2 and 3, Tonopah Test Range and in Hanford Guidance For Radiological Cleanup, respectively Both of these sites assessed a residential exposure scenario and an office/industrial exposure scenario using the RESRAD computer code.

The residential input parameters for the RESRAD computer code from RFETS, the Nevada Test Site (Tonopah Test Range) and the State of Washington are outlined in Table 4, "Preliminary Draft Comparison of Residential RESRAD Input Parameters for the Rocky Flats Environmental Technology Site, Nevada Test Site and Hanford." The office worker/industrial input parameters for the RESRAD computer code from RFETS, the Nevada Test Site (Tonopah Test Range) and the State of Washington are outlined in Table 5, "Preliminary Draft Comparison of Office Worker RESRAD Input Parameters for the Rocky Flats Environmental Technology Site, Nevada Test Site and Hanford."

The RWG has initiated contact with representatives from the States of Nevada and Washington to discuss the differences and similarities between the exposure parameters summarized in Tables 4 and 5 Both sites impacted by these standards are using these standards on an interim basis While the standards derived for the Nevada Test Site (Tonopah Test Range) have been used to guide cleanup at two areas within

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the Tonopah Test Range, these standards are currently under independent review In addition, the RWG was informed that the Washington document is intended to be used as a guidance document on how to develop site specific radionuclide cleanup standards for Operable Units (OU) at DOE's Hanford Site Consequently, for a specific Hanford OU, the radionuclide cleanup standard may be recalculated and a different radionuclide cleanup standard than the one in the Washington document may be selected to guide cleanup

The RWG does not recommend any changes to the RSALs at this time due to the radionuclide cleanup standards currently calculated for these other sites and anticipates that discussions will continue between the three sites into the next year The radionuclide cleanup standards used at the Nevada Test Site (Tonopah Test Range) and the State of Washington will be reviewed periodically by the RWG in order to understand how these standards were derived and to determine if there is any information that may affect the RSALs

6.5 RSAL Path Forward

The RFCA Parties have agreed

- To retain the current RSALs derived using EPA's draft 40CFR196 on a temporary basis,
- To evaluate the regulatory basis for deriving the RSALs,
- To resolve EPA's OSWER guidance calling for a 15 mrem dose standard with NRC's 25 mrem requirement,
- Due to the scientific information being gathered by the AMS, the Independent Oversight Review Panel and the new NRC regulatory guidance being issued in the near future, the RSALs will not be recalculated at this time;
- The latest RESRAD computer code and the DandD computer code need to be assessed for use in recalculating RSALs,
- The final NRC rule and the accompanying guidance need to be reviewed to determine whether the rule should be applied to the Site, a non-NRC facility, however, the RFCA Parties agreed to wait until the guidance was final before undertaking this review;
- The radionuclide cleanup standards from the Nevada Test Site (Tonopah Test Range) and the State of Washington be reviewed periodically in order to understand how these standards are derived and to determine if there is any information that may affect the RSALs

The following will be considered during the review

- NRC Final rule, "Radiological Criteria for License Termination"

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- NRC Regulatory Guide DG-4006, "Decommissioning Compliance with the Radiological Criteria for License Termination"

- NRC NUREG-1549, "Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination"

- NRC Letter Report, "Review of Parameter Data for the NUREG/CR-5512 Residential Farmer Scenario and Probability Distributions for the D and D Parameter Analysis"

- NRC NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM)

After these evaluations are completed, the RSALs may need to be recalculated If the RFCA Parties agree, then the RSALs will be recalculated, however, prior to any changed RSALs being incorporated into RFCA Attachment 5, the public will have an opportunity to comment on the proposed changes as required in RFCA paragraph 117

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TABLE 1,
NEW CERCLA GUIDANCE AND POLICIES

- Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manual (Part D, Standardizing Planning, Reporting, and Review of Superfund Risk Assessment), Interim Final, January 1998

This document is the fourth in a series of guidance manuals on Superfund human health risk assessment This manual provides guidance on standardized risk assessment planning, reporting, and review throughout the CERCLA remedial process, from scoping through remedy selection and completion The guidance does not address standardization of ecological risk assessment, nor does it discuss the risk management decisions that are necessary at a CERCLA site (e g , selection of final remediation goals)

- Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, OSWER Directive 9200 4-17, Interim Final, November 1997

This guidance is designed to promote consistency in how monitored natural attenuation remedies are proposed, evaluated, and approved

- On November 24, 1997, EPA announced two interim policy revisions to the placing of federal facilities on the NPL as well as the deletion of federal facilities already on the list The interim final policy revisions apply to federal facility sites that are RCRA-regulated facilities engaged in the treatment, storage, or disposal of hazardous waste (62 FR 62523)

- Health Effects Assessment Summary Tables (HEAST) FY97 Update

The HEAST is a comprehensive listing of provisional risk assessment information relative to the oral and inhalation exposure pathways for chemicals or interest to Superfund, RCRA, and other EPA programs

- Integrated Risk Information System (IRIS) 1998 Update

IRIS is a database containing scientific analyses of adverse human health effects that may result from chronic exposure to environmental contaminants

- *Superfund Today: Focus on Risk Assessment*

This issue of Superfund Today profiles the human health risk assessment process under CERCLA and presents a case study The document also discusses common cleanup approaches that reduce risks

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- Rules of Thumb for Superfund Remedy Selection

This guidance document describes basic principles and expectations that should be considered during the Superfund remedy selection process It also consolidates and summarizes key elements from various remedy selection guidance documents and policies

- Remediation Case Studies Bioremediation and Vitrification (Volume 5)

This report collects case studies dealing with bioremediation and vitrification projects completed by federal agencies Results from the studies and lessons learned from earlier technology applications are documented throughout the report The studies will help establish benchmark data on cost and performance which should lead to greater confidence in the selection and use of cleanup technologies

- Remediation Case Studies Soil Vapor Extraction and Other In Situ Technologies

This report collects case studies dealing with soil vapor extraction or associated technologies and other in situ technologies such as frozen barrier containment, sonic drilling and fracturing This report was prepared by federal agencies and documents results and lessons learned from earlier technologies The studies will help establish benchmark data on cost and performance which should lead to greater confidence in the selection and use of selected cleanup technologies

- Multi-Agency Radiation Survey and Site Investigation Manual, February 11, 1998 (63 FR 6915)

The Department of Defense, DOE, EPA and the NRC announced the availability for use of the MARSSIM manual, a multi-agency consensus document

- OSWER Directive 9200 4-18 "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination "

This EPA Directive outlines the radiation risk and radiation dose-based levels that EPA feels are protective of human health

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TABLE 2
EXPOSURE PARAMETERS
FOR THE RADIONUCLIDE SOIL ACTION LEVELS (1)

Land Use	Exposure Pathway	Current Intake Rate Exposure Frequency (3)	Proposed Intake Rate Exposure Frequency (6,7)
Residential	Ingestion of Soil/Dust (2)	200 mg/day – 350 days/year	200 mg/day - 350 days/year
	Inhalation of Contaminants	0 83 m^3/hr for 24 hrs/day - 350 days/year	0 83 m^3/hr for 24 hrs/day - 350 days/year
	External Exposure		
	Daily Time Factor	1 - Not Applicable	1 - Not Applicable (8)
	Annual Time Factor	1 - Not Applicable	1 - Not Applicable (8)
	Shielding Factor	0 8 - Not Applicable	0 8 - Not Applicable (8)
	Consumption of Homegrown Produce	42 gram/day – 350 days/year (fruit) 80 gram/day - 350 days/year (vegetable)	42 gram/day - 350 days/year (fruit) 80 gram/day - 350 days/year (vegetable)
	Consumption of Beef/Dairy Products	Not Applicable – Not Applicable (4)	(9)
Office Worker	Ingestion of Soil/Dust	50 mg/day – 250 days/year	50 mg/day - 250 days/year
	Inhalation of Contaminants	0 83 m^3/hr for 8 hrs/day - 250 days/year	1 1 m^3/hr for 8 hrs/day - 250 days/year (10)
	External Exposure		
	Daily Time Factor	0 3 - Not Applicable	0 3 - Not Applicable (8)
	Annual Time Factor	0 7 - Not Applicable	0 7 - Not Applicable (8)
	Shielding Factor	0 8 - Not Applicable	0 8 - Not Applicable (8)
Open Space	Ingestion of Soil/Dust (2)	100 mg/visit - 25 visits/year	100 mg/visit - 100 visits/year (11,12)
	Inhalation of Contaminants	1 4 m^3/hr for 5 hrs/visit - 25 visits/year	1 7m^3/hr for 2 5 hrs/visit 100 visits/year (11,13)
	External Exposure		
	Daily Time Factor	0 21 - Not Applicable	0 1 - Not Applicable (8)
	Annual Time Factor	0 07 - Not Applicable (5)	0 27 - Not Applicable (8)
	Shielding Factor	1 - Not Applicable	1 - Not Applicable (8)
	Ingestion of Surface Water	50 ml/hr for 1 hr/visit - 25 visits/yr	50 ml/hr for 1 hr/visit - 100 visits/yr (11,14)

1 - The Exposure Duration for all exposure scenarios is one year

2 - The RSAL only uses the child ingestion rate for conservatism.

3 - Exposure parameters taken from DOE letter on exposure factors use at RFETS, DOE Letter # 95-DOE-08453

4 – Consumption of Beef/Dairy currently not assessed for RSALs based on OU3 Report radiation dose results.

5 - Annual Time Factor not referenced in DOE Letter, but this factor applied in RSAL for consistency with human health risk assessments.

6 - Based on OSWER Directive 9285.6-03 except where noted.

7 - The proposed changes will be further evaluated as additional information is obtained (e.g., NRC's License Termination Rule and Guidance)

8 - Daily time factor taken from RAGS, Part B for residential and office worker Annual time factor used since Dose Conversion Factor is based on continuous exposure.
Open Space external exposure factors are based on methodology from residential and commercial/industrial factors.

9 - Will be assessed when the NRC's Regulatory Guide on "Demonstrating Compliance with the Radiological Criteria for License Termination" is finalized

10 - Based on ICRP 66, "Human Respiratory Tract Model For Radiological Protection."

11 - *Jefferson County Parks and Open Space Study* – 1996

12 - Based on California Gulch Superfund Site Human Health Risk Assessment

13 - Based on inhalation rates from EPA's 1997 Final Exposure Factors Handbook.

14 - Based on Denver's Lowry Landfill Superfund Site Human Health Risk Assessment

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TABLE 3
RESRAD VERSION HISTORY

The following are the versions of RESRAD that have been distributed since Version 5 61 with their issue date Version 5 61 was used to derive the current Radionuclide Soil Action Levels (RSAL) Each version of RESRAD is listed with the upgrades that were performed before the version was issued

VERSION 5 82 (4/30/98)

- Allow plot data to be exported to tab-delineated text file
- Corrected Installation problem on Windows 3 1
- Corrected plotting problem for soil guidelines

VERSION 5 81 (4/9/98)

- Corrected plotting problem for soil guidelines
- Corrected sensitivity plotting problems with branching radionuclides
- Enhanced file saving checks before running
- Does not allow negative time since waste placement
- Corrected uncertainty plotting problems with branching radionuclides

VERSION 5 80 (3/13/98)

- Support for Windows NT
- Repaired "Export to EXCEL" for latest versions
- Allow sensitivity on leaching and solubility
- Various interface improvements

VERSION 5 782 (10/31/97)

- Fixed various interface problems

VERSION 5 781 (8/29/97)

- Change default Mass Loading Factor in occupancy factor to 0 0001 g/m3
- Easier Cancel option
- Reset Co-60 Plant Transfer Factor

VERSION 5 78 (8/20/97)

- Correctly initialize meat concentrations
- Correct plotting problem with branching radionuclides
- Use exponential notation on plots when appropriate

VERSION 5 77 (8/8/97)

- Do not print peak dose table when peak is a user selected time
- Allow plotting of soil concentrations
- Initialize meat concentration

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VERSION 5 76 (7/25/97)

- Ensure convergence for Kd calculation, given water concentrations
- Disallow user selection of variables not supported for sensitivity analysis
- Add sensitivity description to graphics title
- Add single pathway name to graphics title
- Allow foe sensitivity analysis of single nuclide and single pathway
- Minor interface cleanup
- Installation cleanup
- Add menu selection to allow user to save all reports
- Plot data at time of maximum dose (peak)

VERSION 5 75 (7/4/97)

- Incorporation of new area factor model for inhalation
- Time integrated risk
- User's ability to change radon DCF
- User's ability to change Plant Factors
- Compatibility with Uncertainty Analysis
- DCF Library Save/New feature cleanup
- Graphics look update
- Graphics interface
- Button prompts for navigator
- C14/H3 calculations off then pathways off
- Groundwater reorganization
- External DCF includes beta component

VERSION 5 70 FOR WINDOWS (1/31/97)

- Release of Windows Version with DOS "emulator"
- Runs on Windows 3 1 and Windows 95

VERSION 5 62 (7/3/96)

- Updated default Slope Factors from latest HEAST tables
- Added an error check to the Fortran module to avoid file collisions in Windows

VERSION 5 61 (8/28/95)

- Corrected an error in the calculation of water-independent radon doses for graphic points in cases where the contaminated area is less than 100 meters.
- Corrected an error which caused short-lived radionuclides to have a zero Kd if the calculations are run after changing the half-life, but before going to screen R012
- Corrected an error in the calculation of food storage time correction factors for small concentrations near the end of a decay chain.
- Half-lives were changed to reflect ICRP-38 data

For a discussion of earlier versions of RESRAD, visit the RESRAD Home Page at Argonne National Laboratory (http//www.ead anl gov/resrad html)

TABLE 4
COMPARISON OF RESIDENTIAL RESRAD INPUT PARAMETERS FOR THE
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, NEVADA TEST SITE (TONOPAH TEST RANGE) AND HANFORD

	Parameter	Units	Rocky Flats	Nevada Test Site (Tonopah Test Range)	Hanford
	1-External Gamma		Active	Active	Active
	2-Inhalation		Active	Active	Active
	3-Plant Ingestion		Active	Active	Active
	4-Meat Ingestion		Suppressed	Active	Active
	5-Milk Ingestion		Suppressed	Active	Active
	6-Aquatic Foods		Suppressed	Suppressed	Active
	7-Drinking Water		Suppressed	Active	Active
	8-Soil Ingestion		Active	Active	Active
	9-Radon		Suppressed	Active	Suppressed
R011	Contaminated Zone (CZ)				
	Area of CZ	sq meters	40,000	248000	10,000
	Thickness of CZ	m	0 15	0 05	4 6
	Length Parallel to Aquifer Flow	m	200	1640	100
	Radiation Dose Limit	mrem/yr	15, 85	100	15
	Elapsed Time of Waste Placement	yr	0	0	0
R013	Cover and Contaminated Zone Hydrological Data				
	Cover Depth	m	0	0	0
	Density of Cover Material	g/cm3	Not Used	Not Used	Not Used
	Cover Erosion Rate	m/yr	Not Used	Not Used	Not Used
	Density of CZ	g/cm3	1 8	1 5	1 6
	CZ Erosion Rate	m/yr	0 0000749	0 000031	0 0001
	CZ Total Porosity		0 3	0 3	0 4
	CZ Effective Porosity		0 1	0 3	0 2
	CZ Hydraulic Conductivity	m/yr	44 5	1000	250
	CZ b Parameter		10 4	4 05	4 05
	Humidity in air	g/cm3	Not Used	Not Used	Not Used
	Evapotranspiration Coefficient		0 253	0 68	0 91
	Precipitation	m\yr	0 381	0 127	0 16
	Irrigation Rate	m\yr	1	1 53	0 76
	Irrigation Mode		Overhead	Ditch	Overhead
	Runoff Coefficient		0 004	0 2	0 2
	Watershed Area for Nearby Stream or Pond	m2	8,280,000	311,000	1,000,000
	Accuracy for Water/Soil Computation		0 001	0 001	0 001
R014	Saturated Zone (SZ) Hydrological Data				
	Density of SZ	g/cm3	1 8	1 5	1 6
	SZ Total Porosity		0 3	0 3	0 4
	SZ Effective Porosity		0 1	0 3	0 2
	SZ Hydraulic Conductivity	m/yr	44 5	1000	5530
	SZ Hydraulic Gradient		0 15	0 0001	0 00125
	SZ b Parameter		Not Used	4 05	4 05
	Water Table Drop Rate	m/yr	0	0 0001	0 001
	Well Pump Intake Depth	m	10	10	4 6
	Nondispersion or Mass Balance		Nondispersion	Nondispersion	Nondispersion
	Well Pumping Rate	m3/yr	250	5,180,000	250
R015	Uncont. and Unsat. Strata Hydrological Data				
	Number of Unsaturated Strata		1	1	1
	Thickness	m	3	55	12
	Soil Density	g/cm3	1 8	1 5	1 6
	Total Porosity		0 3	0 3	0 4
	Effective Porosity		0 1	0 3	0 2
	Soil-specific b Parameter		10 4	4 05	4 05
	Hydraulic Conductivity	m/yr	44 5	1000	250
R016	Distribution Coefficients				
	Americium	Cm3/g	76	1900	200
	Plutonium	Cm3/g	218	550	200
	Uranium	Cm3/g	50	35	25

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COMPARISON OF RESIDENTIAL RESRAD INPUT PARAMETERS FOR THE
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, NEVADA TEST SITE (TONOPAH TEST RANGE) AND HANFORD

	Parameter	Units	Rocky Flats	Nevada Test Site (Tonopah Test Range)	Hanford
R017	Soil Inhal , Ingest and External Gamma				
	Inhalation Rate	m3/yr	7000	6820	7300
	Mass Loading for Inhalation	g/m3	0 000026	0 000015	0 0001
	Dilution Length for Airborne Dust	M	3	3	3
	Exposure Duration	Yr	30	30	30
	Inhalation Shielding Factor		1	1	0 4
	External Gamma Shielding Factor		0 8	0 7	0 8
	Indoor Time Factor		1	0 58	0 6
	Outdoor Time Factor		0	0 0155	0 2
	Shape Factor		1	1	1
R018	Ingestion Pathway Data Dietary Parameters				
	Fruits, Vegetables, and Grain Consumption	kg/yr	40 1	120 5	110
	Leafy Vegetable Consumption	kg/yr	2 6	10	2 7
	Milk Consumption	L/yr	Not Used	203 2	100
	Meat and Poultry Consumption	kg/yr	Not Used	93 3	36
	Fish Consumption	kg/yr	Not Used	0	5 4
	Other Seafood Consumption	kg/yr	Not Used	Not Used	Not Used
	Soil Ingestion	g/yr	70	37 4	36 5
	Drinking Water Intake	L/yr	Not Used	444 6	730
	Drinking Water Contamination Fraction		Not Used	1	1
	Household Water Contamination Fraction		Not Used	1	Not Used
	Livestock Water Contamination Fraction		Not Used	Not Used	1
	Irrigation Water Contamination Fraction		0	1	1
	Aquatic Food Contamination Fraction		Not Used	Not Used	0 5
	Plant Food Contamination Fraction		1	1	-1
	Meat Contamination Fraction		Not Used	-1	-1
	Milk Contamination Fraction		Not Used	-1	-1
R019	Ingestion Pathway Data, Nondietary				
	Livestock Fodder Intake for Meat	kg/day	Not Used	68	68
	Livestock Fodder Intake for Milk	kg/day	Not Used	55	55
	Livestock Water Intake for Meat	kg/day	Not Used	50	50
	Livestock Water Intake for Milk	L/day	Not Used	160	160
	Livestock Intake for Soil	kg/day	Not Used	0 5	0 5
	Mass Loading for Foliar Deposition	g/m3	0 0001	0 0000221	0 0001
	Depth of Soil Mixing Layer	M	0 15	0 15	0 15
	Depth of Roots	M	0 9	0 9	0 9
	Groundwater Fractional Usage-Drinking Water		1	1	1
	Groundwater Fractional Usage-Household Usage		Not Used	1	Not Used
	Groundwater Fractional UsageLLivestock Water		Not Used	1	1
	Groundwater Usage Irrigation		Not Used	1	1
R021	Radon				
	Building Foundation Thickness	M	Not Used	0 15	Not Used
	Building Foundation Density	g/cm3	Not Used	2 4	Not Used
	Cover Material Total Porosity		Not Used	Not Used	Not Used
	Building Foundation Total Porosity		Not Used	0 1	Not Used
	Water Content of Cover Material		Not Used	Not Used	Not Used
	Water Content of Foundation		Not Used	0 03	Not Used
	Diffusion Coefficient for Radon Gas		Not Used		Not Used
	Cover Material	m/sec	Not Used	Not Used	Not Used
	Foundation Material	m/sec	Not Used	0 0000003	Not Used
	Contaminated Zone Soil	m/sec	Not Used	0 000002	Not Used
	Vertical dimension of Mixing	M	Not Used	2	Not Used
	Annual Wind Speed	m/sec	Not Used	3 4	Not Used
	Building Air Exchange Rate	1/hr	Not Used	0 5	Not Used
	Height of Building	M	Not Used	2 5	Not Used
	Building Interior Area Factor		Not Used	0	Not Used
	Building Depth Below Ground Surface	M	Not Used	0	Not Used
	Emanating Power of Rn-222 gas		Not Used	0 2	Not Used
	Emanating Power of Rn-220 gas		Not Used	0 15	Not Used

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TABLE 5
COMPARISON OF OFFICE WORKER RESRAD INPUT PARAMETERS FOR THE
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, NEVADA TEST SITE (TONOPAH TEST RANGE) AND HANFORD

	Parameter	Units	Rocky Flats	Nevada Test Site (Tonopah Test Range)	Hanford
R02	Exposure Pathways				
	1-External Gamma		Active	Active	Active
	2-Inhalation		Active	Active	Active
	3-Plant Ingestion		Suppressed	Suppressed	Suppressed
	4-Meat Ingestion		Suppressed	Suppressed	Suppressed
	5-Milk Ingestion		Suppressed	Suppressed	Suppressed
	6-Aquatic Foods		Suppressed	Suppressed	Suppressed
	7-Drinking Water		Suppressed	Active	Suppressed
	8-Soil Ingestion		Active	Active	Active
	9-Radon		Suppressed	Active	Suppressed
R011	Contaminated Zone (CZ)				
	Area of CZ	sq meters	40,000	248000	10,000
	Thickness of CZ	m	0 15	0 05	4 6
	Length Parallel to Aquifer Flow	m	Not Used	1640	100
	Radiation Dose Limit	mrem/yr	15	100	15
	Elapsed Time of Waste Placement	yr	0	0	0
R013	Cover and Contaminated Zone Hydrological Data				
	Cover Depth	m	0	0	0
	Density of Cover Material	g/cm3	Not Used	Not Used	Not Used
	Cover Erosion Rate	m/yr	Not Used	Not Used	Not Used
	Density of CZ	g/cm3	1 8	1 5	1 6
	CZ Erosion Rate	m/yr	0 0000749	0 000031	0 0001
	CZ Total Porosity		0 3	0 3	0 4
	CZ Effective Porosity		0 1	0 3	0 2
	CZ Hydraulic Conductivity	m/yr	44 5	1000	250
	CZ b Parameter		10 4	4 05	4 05
	Humidity in air	g/cm3	Not Used	Not Used	Not Used
	Evapotranspiration Coefficient		0 92	0 68	0 91
	Precipitation	m\yr	0 381	0 127	0 16
	Irrigation Rate	m\yr	0	1 53	0 76
	Irrigation Mode		Not Used	Ditch	Not Used
	Runoff Coefficient		0 004	0 2	0 2
	Watershed Area for Nearby Stream or Pond	m2	Not Used	311,000	1,000,000
	Accuracy for Water/Soil Computation		Not Used	0 001	0 001
R014	Saturated Zone (SZ) Hydrological Data				
	Density of SZ	g/cm3	Not Used	1 5	1 6
	SZ Total Porosity		Not Used	0 3	0 4
	SZ Effective Porosity		Not Used	0 3	0 2
	SZ Hydraulic Conductivity	m/yr	Not Used	1000	5530
	SZ Hydraulic Gradient		Not Used	0 0001	0 00125
	SZ b Parameter		Not Used	4 05	4 05
	Water Table Drop Rate	m/yr	Not Used	0 0001	0 001
	Well Pump Intake Depth	m	Not Used	10	4 6
	Nondispersion or Mass Balance		Not Used	Nondispersion	Nondispersion
	Well Pumping Rate	m3/yr	Not Used	5,180,000	250
R015	Uncont. and Unsat. Strata Hydrological Data				
	Number of Unsaturated Strata		Not Used	1	1
	Thickness	m	Not Used	55	12
	Soil Density	g/cm3	Not Used	1 5	1 6
	Total Porosity		Not Used	0 3	0 4
	Effective Porosity		Not Used	0 3	0 2
	Soil-specific b Parameter		Not Used	4 05	4 05
	Hydraulic Conductivity	m/yr	Not Used	1000	250
R016	Distribution Coefficients				
	Americium	cm3/g	76	1900	200
	Plutonium	cm3/g	218	550	200
	Uranium	cm3/g	50	35	25

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TABLE 5
COMPARISON OF OFFICE WORKER RESRAD INPUT PARAMETERS FOR THE
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, NEVADA TEST SITE (TONOPAH TEST RANGE) AND HANFORD

R017	Soil Inhal , Ingest and External Gamma				
	Inhalation Rate	m3/yr	1660	3150	7300
	Mass Loading for Inhalation	g/m3	0 000026	0 0000136	0 00001
	Dilution Length for Airborne Dust	m	3	3	3
	Exposure Duration	yr	25	30	25
	Inhalation Shielding Factor		1	0 4	0 4
	External Gamma Shielding Factor		0 17	0 7	0 8
	Indoor Time Factor		1	0 228	0 22
	Outdoor Time Factor		0	0 0571	0 014
	Shape Factor		1	1	1
R018	Ingestion Pathway Data, Dietary Parameters				
	Fruits, Vegetables, and Grain Consumption	kg/yr	Not Used	Not Used	Not Used
	Leafy Vegetable Consumption	kg/yr	Not Used	Not Used	Not Used
	Milk Consumption	L/yr	Not Used	Not Used	Not Used
	Meat and Poultry Consumption	kg/yr	Not Used	Not Used	Not Used
	Fish Consumption	kg/yr	Not Used	Not Used	Not Used
	Other Seafood Consumption	kg/yr	Not Used	Not Used	Not Used
	Soil Ingestion	g/yr	12 5	18 25	36 5
	Drinking Water Intake	L/yr	Not Used	218 75	Not Used
	Drinking Water Contamination Fraction		Not Used	1	Not Used
	Household Water Contamination Fraction		Not Used	1	Not Used
	Livestock Water Contamination Fraction		Not Used	Not Used	Not Used
	Irrigation Water Contamination Fraction		Not Used	1	Not Used
	Aquatic Food Contamination Fraction		Not Used	Not Used	Not Used
	Plant Food Contamination Fraction		Not Used	Not Used	Not Used
	Meat Contamination Fraction		Not Used	Not Used	Not Used
	Milk Contamination Fraction		Not Used	Not Used	Not Used
R019	Ingestion Pathway Data, Nondietary				
	Livestock Fodder Intake for Meat	kg/day	Not Used	Not Used	Not Used
	Livestock Fodder Intake for Milk	kg/day	Not Used	Not Used	Not Used
	Livestock Water Intake for Meat	kg/day	Not Used	Not Used	Not Used
	Livestock Water Intake for Milk	L/day	Not Used	Not Used	Not Used
	Livestock Intake for Soil	kg/day	Not Used	Not Used	Not Used
	Mass Loading for Foliar Deposition	g/m3	Not Used	Not Used	Not Used
	Depth of Soil Mixing Layer	m	0 15	Not Used	Not Used
	Depth of Roots	m	Not Used	Not Used	Not Used
	Groundwater Fractional Usage-Drinking Water		Not Used	1	Not Used
	Groundwater Fractional Usage-Household Usage		Not Used	1	Not Used
	Groundwater Fractional UsageLLivestock Water		Not Used	Not Used	Not Used
	Groundwater Usage Irrigation		Not Used	1	Not Used
R021	Radon				
	Building Foundation Thickness	m	Not Used	0 15	Not Used
	Building Foundation Density	g/cm3	Not Used	2 4	Not Used
	Cover Material Total Porosity		Not Used	Not Used	Not Used
	Building Foundation Total Porosity		Not Used	0 1	Not Used
	Water Content of Cover Material		Not Used	Not Used	Not Used
	Water Content of Foundation		Not Used	0 03	Not Used
	Diffusion Coefficient for Radon Gas		Not Used		Not Used
	Cover Material	m/sec	Not Used	Not Used	Not Used
	Foundation Material	m/sec	Not Used	0 0000003	Not Used
	Contaminated Zone Soil	m/sec	Not Used	0 000002	Not Used
	Vertical dimension of Mixing	m	Not Used	2	Not Used
	Annual Wind Speed	m/sec	Not Used	3 4	Not Used
	Building Air Exchange Rate	1/hr	Not Used	0 5	Not Used
	Height of Building	m	Not Used	2 5	Not Used
	Building Interior Area Factor		Not Used	0	Not Used
	Building Depth Below Ground Surface	m	Not Used	0	Not Used
	Emanating Power of Rn-222 gas		Not Used	0 2	Not Used
	Emanating Power of Rn-220 gas		Not Used	0 15	Not Used

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