Kaiser Aluminum
Corporate Environmental Affairs

VIA OVERNIGHT MAIL

February 27, 2004

ATTN: Document Control Clerk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Dose Assessment for Disposal of Kaiser Waste Containing Less than 0.05 Percent by Weight Source Material at US Ecology of Idaho, Inc. (USEI)
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Dear Mr. Buckley:

Enclosed is the subject document. The dose assessment shows that dose to USEI workers and members of the public will be very low.

Please provide a letter indicating NRC accepts the results of the dose assessment and will allow disposal of the Tulsa waste at USEI. Call me at 225/231-5116 if you have any questions.

Very truly yours,

J. W. (Bill) Vinzant
Manager, Corporate Environmental Affairs

JWV/shh
Enclosures

NMSS01

line Avenue, Suite 1A Baton Rouge, LA 70809-1957

cc: Mr. John Buckley – U.S. Nuclear Regulatory Commission
Mr. Dwight Chamberland – U.S. Nuclear Regulatory Commission, Region IV
Ms. Pamela Bishop – Oklahoma Department of Environmental Quality
Ms. Kelly Hunter Burch – State of Oklahoma
Dr. Max Scott – ADA Consultants
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Mr. Paul Handa – Tulsa
Ms. Roberta Fowlkes – Ann Green Communications
Mr. Scott Van Loo – City of Tulsa

DOSE ASSESSMENT FOR DISPOSAL OF KAISER WASTE CONTAINING LESS THAN 0.05 PERCENT BY WEIGHT SOURCE MATERIAL AT US ECOLOGY OF IDAHO, INC. TULSA, OKLAHOMA FACILITY

Prepared for:

KAISER ALUMINUM
CORPORATE ENVIRONMENTAL AFFAIRS

CEC Project 040-341

February 27, 2004

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Dose Assessment for Disposal of Kaiser Waste Containing Less Than 0.05 Percent by Weight Source Material at US Ecology Idaho Facility

1.0 Introduction

This dose assessment was prepared by Civil and Environmental Consultants at the request of Kaiser Aluminum and Chemical Corporation (Kaiser) to calculate dose from radioactive material currently located at the Kaiser Tulsa, Oklahoma site (the site) during transportation and disposal of the material at the US Ecology Idaho (USEI) facility. Much of the site-specific information was provided by USEI in a dose assessment that provided the analytical basis for the permit modification to accept certain low activity radioactive material at the USEI facility, (Reference 1).

Kaiser proposes to dispose of waste containing unimportant quantities of source material as defined in 10 Code of Federal Regulations (CFR) 40.13, i.e., 0.05 percent by weight (wt percent), at USEI. This submittal provides a dose assessment demonstrating that the dose to members of the public from the disposal of this waste at USEI is low compared to the 100 millirem per year (mrem/yr) public dose limit, the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E and 15 mrem TEDE per year from release of radioactive materials for unrestricted use IDAPA 58.01.10.

The detailed assessments supporting these conclusions are presented below.

2.0 Description of the US Ecology Idaho Facility

2.1 Physical Description

Geography - The USEI facility is located 10.5 miles west of the town of Grand View, in Owyhee County, Idaho. The town of Grand View, Idaho has a population of 350. Only one residence is located within 1-1/2 miles of the site (approximately 1 ¼ miles east).

The site is situated on a one-mile wide plateau that slopes from south to north. Maximum surface relief on the facility is 90 feet and the mean surface elevation is 2,600 feet. The site is located in a desert environment with low rainfall and a high evaporation rate. Average rainfall is 7.26 inches per year, while the average evaporation rate is in excess of 42 inches. This high net evaporation rate prevents the migration of significant amounts of surface runoff to off-site locations.

Castle Creek, the nearest surface water, is located 1/2-mile west of the site and lies topographically 150 feet below the facility. The Snake River, the largest surface water source near the site, lies approximately 2-1/2 miles north and 350 feet in elevation below the facility. EPA site evaluations indicate little possibility of site flooding due to a number of factors, primarily low rainfall, high evaporation, and location of the facility outside the 100-year flood plain.

The facility is located within seismic zone 2 and therefore does not require a seismic standard demonstration under 40 CFR Part 264 Appendix IV.

Geology - The USEI facility is situated within the western portion of a 20,000-square mile physiographic unit known as the Snake River Plain. The plain extends from the vicinity of Ashton, Idaho to north of Ontario, Oregon. The Snake River Plain is approximately 350 miles in length and varies in width from 25 to 75 miles. USEI Site B lies within the lowland area of the Owyhee subunit of the Snake River Plain at an elevation range of 2,525 to 2,635 feet.

The geology and hydrogeology beneath the facility have been fully characterized to consistently predict subsurface information. The primary geologic units of interest underlying the facility are the Bruneau and Glenns Ferry Formations.

Hydrogeology - The Bruneau Formation consists of approximately 50-feet of sand and gravel, however, thickness varies greatly and the formation is absent in some locations. The Bruneau Formation is generally more coarse-grained than the underlying Glenns Ferry Formation. The Glenns Ferry Formation is approximately 1,500-feet in thickness in the vicinity of the facility and consists of fluvial sediments that overlie thickly bedded lacustrine deposits.

The fluvial facies, identified as the upper unit of the Glenns Ferry Formation, is approximately 130-feet in thickness and is composed of well-consolidated fine-grained, thinly-bedded sediments. The lacustrine facies, identified as the lower unit of the Glenns Ferry Formation, is composed of thick-bedded clays and silts that contain thin beds of silt, sand, and sand-silt laminae. Two water bearing zones, denoted as the Upper and Lower Aquifers, have been identified in the lacustrine facies of the Glenns Ferry Formation. This extensive lacustrine facies consists of thick-bedded, silty clay to clayey silt that grades with depth into a massive clay. Within the lacustrine facies are discrete intervals of thin lenses of very fine, tuffaceous sand interbedded with thicker, clayey, silt beds. These intervals represent periods of unstable lake margins. During the period of deposition, as water levels declined, lake margins and fluvial sands were deposited further into the lake. When lake levels rose, the sand lenses were covered with additional fine-grained lacustrine sediments (clays). Where these sand zones are saturated, they represent the water-bearing portions of the lacustrine facies of the Glenns Ferry Formation.

The sediments of the Upper Aquifer, represented by the near-shore deposits, are comprised of approximately 3 to 8 cumulative feet of thinly-bedded, fine, silty sand located within 70 to 90 feet of silt and clay. This unit extends to an approximate depth of 210 feet below ground surface. Groundwater flow in the Upper Aquifer is to the east-southeast with an average velocity of 47 feet per year.

In the Upper Aquifer, the near-shore deposits transcend into offshore, deep-lake deposits consisting of thickly-bedded clay. This clay unit, defined as the inner confining bed, varies in

thickness from 20 to 30 feet, but is continuous beneath the site. The inner confining bed extends to a depth of approximately 230 feet. This offshore deposit then transcends into another near-shore deposit comprised of thick-bedded silt and thinly-bedded clay that contain thin-bedded sand and sand laminae that extends to a depth of approximately 260 feet. It is within this unit that the Lower Aquifer exists. The Lower Aquifer consists of approximately 4 cumulative feet of sand within this 30 to 40 feet thick sequence of bedded silts and clays. Groundwater in the Lower Aquifer is under slight artesian pressure and flows to the northeast with and average velocity of 7 feet per year. Beneath the Lower Aquifer, the sedimentary sequence transcends into another deep offshore deposit that consists of very thickly-bedded clays and fine silts.

Ground Water Monitoring - Currently, USEI has eighteen (18) piezometers and thirty-two (32) monitoring wells located within the two aquifers. In accordance with USEI Part B RCRA and TSCA Permits, TOC, TOX, pH, Specific Conductivity, and a custom list of 26 VOCs are monitored. Sampling for PCB analysis is performed on an annual basis. Groundwater sampling is performed in accordance with the requirements of USEI's current operating permits. Analysis is performed by an outside contract laboratory. The results of the semi-annual groundwater sampling and analysis activities are submitted to IDEQ semi-annually, in accordance with the requirements of the RCRA Permit, and to U.S. EPA Region 10 on an annual basis, in accordance with the requirements of the TSCA Permit.

Storm Water - The high net evaporation rate prevents the migration of significant amounts of surface runoff to locations off-site. Runoff due to heavy rains is addressed through a runoff drainage, collection, and containment system. The system directs runoff from the interior of the site. The runoff drains into one of three on-site impoundments. Runoff collected in the on-site runoff impoundments is periodically tested and piped to the solar evaporation pond. A run-on diversion system prevents run-on from entering the facility.

Site drainage and runoff controls are designed to contain and control runoff from a 25-year, 24-hour storm (1.75 inches of precipitation). Active waste disposal, storage, and treatment operations are segregated from uncontaminated areas by a series of diversion berms and channels. The control system consists of drainage swales, engineered grades, drainage conduits, flumes, riprap, and surface impoundments.

A system of interceptor channels collects and conveys runoff from the active waste handling areas to the rainwater collection ponds. Runoff from clean areas to the active are is prevented by a series of dikes and channels around active units. Runoff is transferred from Collection Ponds 1, 2, and 3 to the Solar Evaporation Pond for solar treatment.

Runoff from the active areas are collected within the unit and transferred to storage tanks and treated as multi-source leachate.

2.2 Facility Design and Operation

Landfill Cells - Two RCRA/TSCA landfill cells are currently in operation at USEI. The cells are used to dispose of containerized solids, bulk solids, electrical equipment, (i.e., small capacitors, transformer carcasses, etc.). USEI operates Cells 5 and 14 under the joint Idaho/EPA Part B Permit. PCB's are disposed in Cells 5 and 14 under the EPA PCB Disposal Permit. Authorization to construct a third cell designated Cell 15 was granted on February 14, 2003. Construction of this cell was initiated on March 1, 2003 and was scheduled to be in operation by the end of 2003. Cell 15 is designated to contain over 3.6 million cubic yards of material.

Liner System - USEI's landfill liner system (Cell 5, Cell 14, Cell 15) consists of a dual composite liner with a leak detection system overlying the primary liner. The liner system was constructed from bottom to top as indicated:

- Subgrade: In-situ compacted silty, sandy soil.
- Secondary Soil Liner: Minimum 36-inches of recompacted clay with a permeability of less than 1E-7 cm/sec.
- Secondary Flexible Membrane Liner: 60-mil high-density polyethylene.
- Leak Detection Zone: Composite layers consisting of a synthetic drainage net, geotextile fabric, 12-inches of stone, and a secondary geotextile fabric.
- Primary Soil Liner: Minimum of 18-inches recompacted clay with a permeability of less than 1E-7 cm/sec (on the bottom of the cell).
- Primary Flexible Membrane Liner: 80-mil high-density polyethylene.

- Primary Leachate Collection Zone: Composite layer consisting of a synthetic drainage net, geotextile fabric, 12-inches of sand, and a second geotextile fabric.
- Protective Layer: 6-inches of compacted soil.

Leachate Management

Collection: The leachate collection system drains and traps moisture and liquids percolating through the landfill. The leachate collection system is protected from clogging by a geotextile filter and protected from physical disturbance by 6-inches of soil. Cells are graded so that liquids drain through layers to sumps in the center of the cell. The sumps are pumped according to a Leachate Management Schedule.

Inspection: Leachate levels are checked weekly in the primary leachate systems and daily in the secondary leak detection collection and removal system. Both sumps are checked in the event the facility receives more than ½ -inches of rainfall in a 24-hour period. Leachate is pumped and removed in accordance with action levels established in the Part B Permit. Records are maintained for each pumping event. Pumping records indicate leachate levels before and after pumping, the volume pumped, and the on-site disposition of the leachate.

Treatment: The leachate is managed in accordance with 40 CFR Part 268.7. The leachate is treated using a carbon absorption system. The treated leachate is stored until the required testing is completed. Upon passing the required parameters, the leachate is disposed in the solar evaporation pond.

Surface Impoundments: USEI has three surface impoundments for the collection of storm water runoff (Rainwater Collection Ponds 1, 2, and 3). A fourth surface impoundment is a RCRA permitted treatment and disposal unit for solar evaporation (Evaporation Pond 1).

Liner System: USEI's Surface Impoundments are constructed with dual synthetic liner systems and associated leak detection capabilities. (Reference 2)

Post-Closure Plan: As required by the Idaho Department of Environmental Quality in IDAPA 58.01.10, US Ecology Idaho maintains an approved closure plan, submitted as part of its permit

application. The plan conforms to all standard closure and post-closure requirements applicable to RCRA disposal facilities, including post-closure monitoring and financial assurance. The plan provides reasonable assurance that the radon emanation rate from the closed disposal unit will not exceed twenty (20) picocuries per square meter per second averaged across the entire area of the closed disposal unit and reasonable assurance that the general radiation protection standard for the public (TEDE of 100 mrem/yr) will not be exceeded, (Reference 3).

3.0 Safety Analysis and Dose Assessment for Disposal of Kaiser Waste at the US Ecology Idaho Facility

3.1 Source Term

The Kaiser waste contains thorium and radium, but essentially no uranium. The presence of thorium in soil at the Tulsa site is the result of historical operations that involved the recycling of magnesium-thorium alloy from aircraft scrap which was used in the smelting and manufacture of magnesium anodes. Since uranium is not present, the calculation of 0.05 wt percent source material involves only thorium. The thorium concentration of the Kaiser waste approaches 55 picoCuries per gram (pCi/g) Th-232, corresponding to the 0.05 wt percent. Thorium-228 and Th-230 are also present but because of their very high specific activity relative to Th-232, they are not a factor in the 0.05 wt percent calculation. Radium-226 and Ra-228 are also present but not accounted for in the 0.05 wt percent concentration determination because radium is not source material as defined in 10 CFR 40. However, Ra-226 and Ra-228 are included in the dose assessment. Th-232, Ra-228, and Th-228 for the Kaiser waste are in secular equilibrium. Th-230 concentrations are 3.5 times as much as Th-232. Concentrations of Ra-226 and Pb-210 were calculated from the Th-230 in growth considering an elapsed time of 55 years since material production. This results in Ra-226:Th-230 and Pb-210:Th-230 ratios of 0.0235 and 0.0123 respectively. The ratios of each nuclide of concern to Th-232 are given in the table below (Reference 4).

Table 3.1
Radionuclide Ratios

Radionuclide	Ratio to Th-232
Pb-210	0.043
Ra-226	0.082
Ra-228	1
Th-228	1
Th-230	3.5
Th-232	1

3.2 Dose to USEI Workers

US Ecology Idaho is required by condition of its Department of Environmental Quality permit to operate in a way that assures that the highest potential dose to a worker handling radioactive material is 400 mrem TEDE per year, and that assures that the highest potential dose to a member of the public is 100 mrem TEDE per year from operations or 15 mrem TEDE per year from release of radioactive materials for unrestricted use. To meet these requirements, US Ecology Idaho conducts its operations in accordance with its Radioactive Material Health and Safety Manual and other operating procedures. These procedures include measures for minimizing release of material in receipt and handling. Workers use mechanized equipment to transfer and deposit material in the disposal cell. Materials placed in the cell are covered each day with a stabilizing layer of soil at least several inches thick to minimize the potential for release of radioactive materials to the atmosphere (Reference 3).

There are two types of activities that result in non-negligible dose to USEI workers. The first involves radiation protection (RP) technicians who survey incoming railcars and the second involves drivers that transport the waste from the rail to the facility and unload the waste. An estimate of this potential dose follows:

An RP technician may require 1/2 hour to inspect and perform a survey of an incoming railcar. The average distance from the railcar is conservatively assumed to be 3 feet. The actual distance is greater since part of the time is performing a survey at 3 meters. A MicroShield (Reference 5) calculation was performed using the Kaiser waste profile and the specific dimensions of the railcars to be used for shipping the Kaiser waste (52.5 ft L × 9.5 ft W × 5 ft H). Although the railcar has a volume of 92 cubic yards (cy), it cannot be filled completely with soil-like material. It is assumed the railcars will hold 85 cy of the waste material, however the MicroShield calculations are conservatively based on the source material filling the full volume of the railcar. The MicroShield report for this analysis is provided in Attachment 1.

The resulting dose per railcar survey is 1.483E-05 mrem (2.965E-05 mrem/hr × 0.5 hr). The dose for an individual radiation protection technician is calculated as follows assuming that there

are four RP technicians at USEI that are equally likely to perform the survey, 37,040 cy of waste, and 85 cy per railcar:

$$Dose_{USEI\ RP\ Technician} = \frac{(1.483E\text{-}05\ mrem\ per\ RP\ Tech\ per\ railcar)(37{,}040\ cy\ waste)}{(4\ RP\ Techs)(85\ cy\ per\ railcar)} = 1.616E\text{-}03\ mrem$$

The dose to the USEI driver is also calculated using MicroShield and the Kaiser waste profile. Assuming that the dimensions of the trucks used at USEI are 25 ft L × 6 ft W × 3 ft H, they would hold a volume of 450 ft^3 (16.7 cy). The driver would be 5 feet from the waste and would require 1 hour to load the truck, transport to the disposal cell, and unload. In addition to the truck driver, dose to an excavator operator unloading the railcar into the truck is considered in this calculation. The resulting dose is 1.029E-05 mrem per load (1.029E-05 mrem/hr × 1 hr). Assuming three drivers that are equally likely to haul the waste, plus one excavator operator, 37,040 cy of waste, and 15.5 cy per load (using the argument above for filling the truck), the individual driver dose is calculated as follows:

$$Dose_{USEI\ Driver/Operator} = \frac{(1.029E\text{-}05\ mrem/load)(37{,}040\ cy\ waste)}{(4\ drivers/operators)(15.5\ cy/load)} = 6.147E\text{-}03\ mrem$$

The MicroShield report for this analysis is provided in Attachment 2.

3.3 Dose to Members of the Public

There are three categories of individual members of the public that may be exposed as a result of the transport and disposal of exempt quantity waste. These are 1) railroad crew members and other railroad employees, 2) off-site residents in the vicinity of USEI during disposal, and 3) future onsite resident after the USEI facility closes. The doses to these members of the public are calculated below.

3.3.1 Rail Transportation

The Kaiser waste will be transported to USEI by rail. The individual dose was calculated for the train crewmember and to a railroad employee at a rail station. The calculation was performed using MicroShield and guidance provided in NUREG-0170, Vol.1, "Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes", Table 4-9. These doses are calculated as follows:

$$Dose_{crew} = \frac{(1{,}173 \text{ mi/shipment})(3.342E\text{-}10 \text{ mrem/hr})(44 \text{ shipments})}{(25 \text{ mi/hr})} = 6.899E\text{-}07 \text{ mrem}$$

Where: 1,173 mi = estimated distance from Kaiser to USEI
25 mi/hr = average train speed in medium-population areas (per NUREG-0170)
3.342E-10 mrem/hr = crew member exposure rate from Kaiser waste calculated using MicroShield and assuming an average separation distance of 152 m (per NUREG-0170, Table 4-9).
44 shipments = 37,040 cy Kaiser waste ÷ 850 cy (assuming 10 Kaiser cars per shipment @ 85 cy per car)

$$Dose_{rail\ employee} = (1.162E\text{-}06 \text{ mrem/hr})(0.25 \text{ hr/shipment})(44 \text{ shipments}) = 1.278E\text{-}05 \text{ mrem}$$

Where: Calculation assumes one station employee spends 15 minutes at a distance of 15 meters from a railcar (NUREG-0170, Section 4.3.3.1.3) for all of the Kaiser shipments.

The MicroShield reports for these two calculations are provided in Attachments 3 and 4, respectively.

3.3.2 Offsite Resident During USEI Operations

Releases of radioactivity in effluents to the general environment are maintained at release levels below the allowable limits and ALARA through the implementation of an effective radiation

control program. The radiological dose to an off-site resident during the disposal of the Kaiser waste is assumed to occur from airborne radioactivity generated during waste handling operations at USEI, i.e., the loading and unloading of trucks. The estimated potential dose for the disposal of material containing 0.05% by weight thorium and its progeny was calculated to be 0.056 mrem, (Reference 3). This potential dose was for a waste volume of 3,800 cubic meters, therefore the estimate dose for the disposal of the 28,319 cubic meters (37,040 cy) of Kaiser waste is 0.42 mrem.

3.3.3 Dose to Future On-Site Resident After Site Closure

USEI has prepared a bounding analysis that assesses releases to the general environment from the disposal of unimportant concentration of source material after disposal site closure. This analysis calculates a dilution factor of 0.50 of radioactive to non-radioactive waste received at the site, (Reference 1). An analysis using the RESRAD computer code V 6.2 (Reference 6) has been performed to demonstrate that unimportant quantities of Kaiser source material mixed with other waste can be disposed at the USEI facility without exceeding a 25 mrem/yr effective dose to the maximum exposed individual.

3.3.3.1 Land Use and Exposure Pathways

After closure of the landfill, it is possible that people could be exposed to radioactive materials from unrestricted use of the landfill site in a number of ways, depending on potential uses of land and groundwater resources. Over the long term, assumed for this analysis to be 1,000 years, use of the site for residential and agricultural purposes, though unlikely, would be the possible uses most likely to maximize radiation exposure. Use of groundwater containing landfill constituents for domestic and agricultural purposes or for irrigation is unlikely. The landfill siting and construction requirements are designed to minimize the potential for migration of landfill constituents to groundwater. Nevertheless, such use is assumed to be possible for purposes of this analysis.

Given assumed potential land and water uses, exposure of hypothetical future inhabitants of the landfill site to residual radioactive material in fill materials on the landfill site could hypothetically

occur through one or more of three terrestrial pathways (water independent pathways), depending on the location of soils containing residual radioactive material with respect to the ground surface. If residual radioactive material were contained within soils at or near the ground surface, exposure could occur from radiation emitted directly from radioactive material in place in the soil, from inhalation of air containing residual radioactive material (either resuspended from soil at the ground surface or produced from the radioactive decay of radon gas emitted from the soil), or from ingestion of residual radioactive material taken up from soils into garden products produced on the site. For significant exposure through terrestrial pathways, removal of the 3.6-meter earthen cover and exposure of the fill material would be required. For the pathways involving groundwater use (water dependent pathways), radiation exposure could result from ingestion of water and from ingestion of radioactive material taken up from irrigation water into garden products produced on the site. Domestic animals might drink well water or eat vegetation irrigated by well water.

A hypothetical landfill site inhabitant scenario that incorporates almost all possible exposure pathways would be a resident farmer who uses groundwater for domestic and agricultural purposes. Because this scenario incorporates almost all of the potential exposure pathways, it is most likely to result in the highest dose, and, for that reason, is selected as the scenario that represents maximum potential impact from habitation of the site. More realistic exposure scenarios would exclude some potential pathways and would result in lower calculated doses. The pathways included for analysis are:

(1) Ground

- Direct radiation from material in soil

(2) Dust

- Resuspension of surface particulate material—air-inhalation

(3) Radon (water independent)

- Release of radon gas from radioactive material in near-surface soils to residence interior–in growth of airborne particulate radon daughter products-inhalation

(4) Plant (water independent)

- Resuspension of surface particulate material--air--deposition or uptake in edible plant tissue--ingestion

- Uptake of material in soil through roots of edible plants-ingestion

(5) Meat or Milk (water independent)

- Resuspension of surface particulate material--air--deposition or uptake in edible plant tissue--ingestion by animal--ingestion of animal product

- Uptake of material in soil through roots of edible plants--ingestion by animal--ingestion of animal product

(6) Soil

- Ingestion of soil

(7) Water

- Release of materials in soil to infiltrating water-groundwater-ingestion

- Release of materials in soil to infiltrating water--groundwater--transport to surface water--ingestion

(8) Radon (water dependent)

- Release of radon gas from groundwater brought into residence--in growth of airborne particulate radon daughter products-inhalation

(9) Plant (water dependent)

- Release of materials in soil to infiltrating water--groundwater--transport to surface as irrigation water--deposition or uptake in edible plant tissue-ingestion

(10) Meat or Milk (water dependent)

- Release of materials in soil to infiltrating water--groundwater--transport to surface water--ingestion by animal--ingestion of animal product

- Release of materials in soil to infiltrating water--groundwater--transport to surface as irrigation water--deposition or uptake in edible plant tissue--ingestion by animal--ingestion of animal product

3.3.3.2 Parameters

Some values of parameters in RESRAD were entered specifically describing the US Ecology Idaho site. These site-specific parameters are listed below and were supplied by US Ecology Idaho as part of its application supporting its recent permit modification related to radioactive materials disposal, (Reference 1).

- Thickness of unsaturated zone (61 m by measurement of depth to water)
- Length parallel to aquifer flow (5.430E+02 m)
- Hydraulic gradient of the saturated zone (0.007)
- Hydraulic conductivity of the saturated zone (6.7 m/yr)
- Contaminated zone hydraulic conductivity (31.6 m/yr)
- Evapotranspiration coefficient (0.75) precipitation (0.184 m)
- Density of cover (1.78 g/cc—weighted average based on the thickness of each layer of cover)
- Cover depth equals 3.6 meters (total distance between radioactive material and top of RCRA cap)
- Cover total porosity (0.413—weighted average based on porosity of each layer of cover)
- Cover volumetric water content (0.0265, weighted average of volumetric water content of all cover layers.)
- Cover radon diffusion coefficient (7.233E-07 m^2/sec—diffusion coefficient for first layer of cover.)
- Contaminated zone radon diffusion coefficient (5.471E-07 m^2/sec—calculated by RESRAD based on other inputs.)
- Building air exchange rate (1.5/hr—based on range of average ventilation rates in houses)
- Cover erosion rate (0.0001 m/yr—based on lack of precipitation and materials of construction for cover.)

Except for the concentrations of radionuclides assumed in the waste material and its density, all other values used for the RESRAD calculations are default values.

3.3.3.3 Radioactive Source Term

The thorium radionuclides and their in growth (55 years) progeny were entered in RESRAD in concentration corresponding to the Kaiser waste characterization multiplied by the USEI dilution factor. This dilution factor assumes that the Kaiser waste is half of the total waste received during the time period of the shipments. Radioactivity concentrations entered were:

Table 3.2
Kaiser Waste Radionuclide Concentrations

Radionuclide	Kaiser Waste Concentration (pCi/g)	Kaiser Waste * Dilution (0.5) Disposal Concentration (pCi/g)
Pb^{210}	2.365	1.18
Ra^{226}	4.510	2.26
Ra^{228}	55	28
Th^{228}	55	28
Th^{230}	192.5	96.25
Th^{232}	55	28

Over the 1,000 years simulated, short-lived radioactive progeny grow to radioactive equilibrium with their parent radionuclides.

3.3.3.4 Results

Detailed results of the RESRAD calculations are in Attachment 5. The maximum potential radiological dose to a hypothetical future resident farmer on the USEI site from all exposure pathways is estimated by RESRAD to be 4.25 mrem/yr at 1,000 years. This is well within the U.S. Nuclear Regulatory Commission (NRC) requirement that the potential dose consequence to members of the public from the proposed disposal at USEI be substantially less than 25 mrem/year.

3.3.3.5 Waste from Kaiser

As stated above, the Kaiser waste radionuclide concentrations, corresponding to 0.05 wt percent source material, are 55 pCi/g Th-232 and Th-228, with a corresponding concentration of 192.5 pCi/g Th-230; 4.510 pCi/g Ra-226 and 55 pCi/g Ra-228; and 2.365 pCi/g Pb-210. The result of the RESRAD analysis was 4.25 mrem/year at 1000 years.

3.4 Collective Dose

The collective dose from disposal of the Kaiser waste at USEI was calculated for USEI workers, members of the public including transportation, off-site resident, and future on-site resident.

The collective dose for USEI workers is calculated based on the RP technician and driver exposure scenarios and the number of workers exposed.

USEI Workers: ((1.616E-03 mrem/RPT x 4 RPT) + (6.147E-03 mrem/driver x 4 drivers)) x 1rem/1,000mrem = 3.105E-05 person-rem.

The transportation collective dose calculation assumed five crewmembers (NUREG-0170, Table 4-9), each receiving a dose of 6.899E-07 mrem in addition to 1.278E-05 mrem for one rail employee standing next to each railcar, for the shipment of all Kaiser waste.

Rail Transportation Workers: ((6.899E-07 mrem/crew x 5 crew members) + (1.278E-05 mrem/employee x 1 employee)) x 1rem/1000mrem = 1.62E-08 person-rem.

The collective dose for the off-site resident is 0.42 mrem. (See Section 3.3.2).

The collective dose to the future on-site resident is 4.25 mrem/year at 1000 years.

4.0 Conclusions of Analyses

Kaiser proposes to dispose of contaminated soil from its Tulsa facility by transfer to the US Ecology Idaho facility. Kaiser will only transfer waste containing unimportant quantities of source material, i.e., less than 0.05 wt percent. Estimates of individual and collective dose to members of the public and to USEI workers were made to evaluate the consequence of disposing the Kaiser waste at the USEI facility. The doses are listed in Table 4.1.

In conclusion, the doses from the shipment of exempt Kaiser waste to USEI are below the 100 mrem/yr public dose limit and the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E.

Table 4.1
Individual and Collective Kaiser Disposal Dose

Exposure Scenario	Individual Dose (mrem)	Collective Dose (person-rem)
USEI Workers	6.147E-03 mrem (driver/operator) 1.616E-03 mrem (RPT)	3.105E-05
Rail Transport Workers	6.899E-07 (crew) 1.278E-05 (employee)	1.62E-08
Off-Site Resident	0.42	0.42
Future On-Site Resident	4.25	4.25

4.0 References

1. US Ecology Idaho, Inc., "Report on Analytical Basis for Waste Acceptance Criteria Revisions to Accept Naturally Occurring and Certain Other Low Activity Radioactive Material", 2001.
2. US Ecology Idaho, Inc, Audit Response Package 2003.
3. Mallinckrodt, Inc., "Proposal to transfer certain solid wastes from decommissioning C-T process buildings & transmittal of report, Disposal of Mallinckrodt 10 CFR Part 40 section 13(a) Material at US Ecology Idaho Site", June 2002.
4. Decommissioning Plan, Kaiser Tulsa Facility, May 2003.
5. MicroShield Version 6.02, Grove Engineering, Rockville, MD, 1995-99.
6. RESRAD, Version 6.2, Argonne National Laboratory, Chicago, IL, 2002.

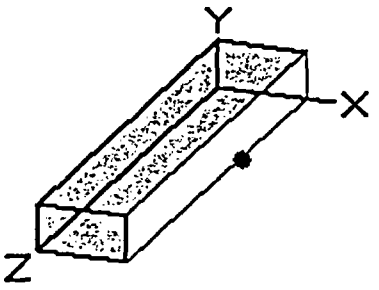
MicroShield v6.02 (6.02-00204)
CEC,_Inc.

Page	:1	**File Ref**	:
DOS File	:KUSEIR1.ms6	**Date**	:
Run Date	: February 18, 2004	**By**	:
Run Time	: 12:35:29 PM	**Checked**	:
Duration	: 00:00:05		

Case Title: Kaiser Rail Car
Description: RP Survey at 3 Feet
Geometry: 13 - Rectangular Volume

Source Dimensions:

Length	289.56 cm	(9 ft 6.0 in)
Width	1.6e+3 cm	(52 ft 5.9 in)
Height	152.4 cm	(5 ft 0.0 in)



Dose Points

A	X	Y	Z
# 1	381 cm	76.2 cm	800.1 cm
	12 ft 6.0 in	2 ft 6.0 in	26 ft 3.0 in

Shields

Shield N	Dimension	Material	Density
Source	7.06e+07 cm³	FGR12 Soil	1.36
Shield 1	.635 cm	Iron	7.86
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Pb-210	2.2710e-004	8.4027e+006	3.2164e-006	1.1901e-001
Ra-226	4.3307e-004	1.6024e+007	6.1336e-006	2.2694e-001
Ra-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-230	1.8485e-002	6.8395e+008	2.6180e-004	9.6867e+000
Th-232	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000

Buildup : The material reference is - Source
Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Attachment 1

Energy MeV	Activity Photons/sec	Results Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0067	1.214e+02	1.028e-146	4.703e-33	4.723e-147	2.161e-33
0.0108	2.044e+06	2.804e-142	1.282e-28	6.748e-143	3.087e-29
0.0117	1.285e+05	1.910e-143	8.738e-30	3.577e-144	1.636e-30
0.0123	1.868e+07	2.918e-141	1.335e-27	4.671e-142	2.137e-28
0.0123	5.766e+07	9.007e-141	4.120e-27	1.442e-141	6.595e-28
0.0123	1.640e+07	2.561e-141	1.172e-27	4.100e-142	1.875e-28
0.0465	3.403e+05	1.569e-10	9.762e-10	4.850e-13	3.018e-12
0.059	3.713e+05	1.397e-07	1.258e-06	2.836e-10	2.554e-09
0.0677	2.551e+06	9.832e-06	9.677e-05	1.720e-08	1.693e-07
0.0811	2.888e+04	8.672e-07	8.616e-06	1.366e-09	1.357e-08
0.0838	4.797e+04	1.916e-06	1.889e-05	2.987e-09	2.945e-08
0.0844	2.364e+06	1.001e-04	9.849e-04	1.557e-07	1.533e-06
0.0949	2.175e+04	2.140e-06	2.010e-05	3.275e-09	3.076e-08
0.125	8.207e+04	3.008e-05	2.368e-04	4.740e-08	3.732e-07
0.1316	2.423e+05	1.064e-04	8.080e-04	1.695e-07	1.288e-06
0.1681	4.714e+05	4.145e-04	2.677e-03	7.024e-07	4.536e-06
0.1725	2.244e+05	2.101e-04	1.335e-03	3.584e-07	2.277e-06
0.1862	5.256e+05	5.862e-04	3.555e-03	1.018e-06	6.173e-06
0.216	4.670e+05	7.117e-04	3.954e-03	1.277e-06	7.095e-06
0.3097	1.069e+03	3.189e-06	1.450e-05	6.073e-09	2.761e-08
Totals	**1.026e+08**	**2.177e-03**	**1.371e-02**	**3.759e-06**	**2.355e-05**

MicroShield v6.02 (6.02-00204)
CEC,_Inc.
Custom Material : FGR12 Soil
FGR 12 Soil
Density : 1.36 g/cm³
Average Atomic Number : 10.53 (based on average elements Z)
Effective Atomic Number : 12.17 (for Buildup Factor Interpolation)
Effective Atomic Weight : 21.2

	1 100.000%
Hydrogen	0.021
Carbon	0.016
Oxygen	0.577
Aluminum	0.05
Silicon	0.271
Potassium	0.013
Calcium	0.041
Iron	0.011

MicroShield v6.02 (6.02-00204) 02/18/04

MicroShield v6.02 (6.02-00204)
CEC,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\CaseFiles\KUSEIR1.ms6
Case Title: Kaiser Rail Car
This case was run on Wednesday, February 18, 2004 at 12:42:21 PM
Dose Point # 1 - (381,76.2,800.1) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	1.258e-002	8.281e-002
Photon Energy Fluence Rate	MeV/cm²/sec	2.177e-003	1.371e-002
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	3.759e-006	2.355e-005
Absorbed Dose Rate in Air	mGy/hr	3.282e-008	2.056e-007
"	mrad/hr	3.282e-006	2.056e-005
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	4.692e-008	2.965e-007
o Opposed	"	2.952e-008	1.851e-007
o Rotational	"	2.948e-008	1.847e-007
o Isotropic	"	2.724e-008	1.711e-007
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	4.690e-008	2.962e-007
o Opposed	"	4.123e-008	2.585e-007
o Rotational	"	4.123e-008	2.585e-007
o Isotropic	"	2.927e-008	1.837e-007
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	4.062e-008	2.565e-007
o Posterior/Anterior	"	3.299e-008	2.078e-007
o Lateral	"	2.150e-008	1.350e-007
o Rotational	"	2.847e-008	1.792e-007
o Isotropic	"	2.338e-008	1.469e-007

MicroShield v6.02 (6.02-00204)
CEC,_Inc.

Page	:1	**File Ref**	:
DOS File	:KUSEIT1.ms6	**Date**	:
Run Date	: February 18, 2004	**By**	:
Run Time	: 1:00:00 PM	**Checked**	:
Duration	: 00:00:04		

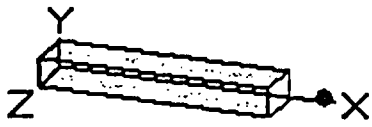
Case Title: Truck at USEI
Description: Truck Driver at USEI
Geometry: 13 - Rectangular Volume

Source Dimensions:

Length	762.0 cm	(25 ft)
Width	182.88 cm	(6 ft)
Height	91.44 cm	(3 ft)

Dose Points

A	X	Y	Z
# 1	914.4 cm	45.72 cm	91.44 cm
	30 ft	1 ft 6.0 in	3 ft



Shields

Shield N	Dimension	Material	Density
Source	1.27e+07 cm³	FGR12 Soil	1.36
Shield 1	.318 cm	Iron	7.86
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Pb-210	4.0985e-005	1.5164e+006	3.2164e-006	1.1901e-001
Ra-226	7.8158e-005	2.8918e+006	6.1336e-006	2.2694e-001
Ra-228	9.5315e-004	3.5267e+007	7.4800e-005	2.7676e+000
Th-228	9.5315e-004	3.5267e+007	7.4800e-005	2.7676e+000
Th-230	3.3360e-003	1.2343e+008	2.6180e-004	9.6866e+000
Th-232	9.5315e-004	3.5267e+007	7.4800e-005	2.7676e+000

Buildup : The material reference is - Source
Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Attachment 2

Energy MeV	Activity Photons/sec	Results Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0067	2.190e+01	3.124e-107	7.358e-34	1.435e-107	3.380e-34
0.0108	3.689e+05	8.519e-103	2.006e-29	2.050e-103	4.829e-30
0.0117	2.320e+04	5.804e-104	1.367e-30	1.087e-104	2.560e-31
0.0123	3.371e+06	8.867e-102	2.088e-28	1.419e-102	3.342e-29
0.0123	1.041e+07	2.737e-101	6.445e-28	4.380e-102	1.032e-28
0.0123	2.959e+06	7.783e-102	1.833e-28	1.246e-102	2.934e-29
0.0465	6.142e+04	5.387e-09	2.874e-08	1.666e-11	8.887e-11
0.059	6.701e+04	4.951e-07	3.795e-06	1.005e-09	7.704e-09
0.0677	4.604e+05	1.553e-05	1.333e-04	2.718e-08	2.333e-07
0.0811	5.212e+03	6.751e-07	6.143e-06	1.063e-09	9.675e-09
0.0838	8.657e+03	1.355e-06	1.236e-05	2.112e-09	1.927e-08
0.0844	4.267e+05	6.941e-05	6.334e-04	1.080e-07	9.858e-07
0.0949	3.925e+03	1.127e-06	1.018e-05	1.725e-09	1.558e-08
0.125	1.481e+04	1.090e-05	8.776e-05	1.717e-08	1.383e-07
0.1316	4.373e+04	3.693e-05	2.888e-04	5.887e-08	4.604e-07
0.1681	8.507e+04	1.267e-04	8.486e-04	2.147e-07	1.438e-06
0.1725	4.050e+04	6.369e-05	4.193e-04	1.086e-07	7.150e-07
0.1862	9.485e+04	1.741e-04	1.089e-03	3.023e-07	1.890e-06
0.216	8.429e+04	2.059e-04	1.163e-03	3.694e-07	2.086e-06
0.3097	1.929e+02	8.981e-07	3.969e-06	1.710e-09	7.559e-09
Totals	**1.852e+07**	**7.077e-04**	**4.699e-03**	**1.214e-06**	**8.007e-06**

MicroShield v6.02 (6.02-00204)
CEC,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\CaseFiles\KUSEIT1.ms6
Case Title: Truck at USEI
This case was run on Wednesday, February 18, 2004 at 1:00:00 PM
Dose Point # 1 - (914.4,45.72,91.44) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	4.479e-003	3.149e-002
Photon Energy Fluence Rate	MeV/cm²/sec	7.077e-004	4.699e-003
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	1.214e-006	8.007e-006
Absorbed Dose Rate in Air	mGy/hr	1.060e-008	6.990e-008
"	mrad/hr	1.060e-006	6.990e-006
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.541e-008	1.029e-007
o Opposed	"	9.554e-009	6.312e-008
o Rotational	"	9.524e-009	6.286e-008
o Isotropic	"	8.847e-009	5.861e-008
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.539e-008	1.027e-007
o Opposed	"	1.333e-008	8.800e-008
o Rotational	"	1.333e-008	8.800e-008
o Isotropic	"	9.484e-009	6.274e-008
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	1.330e-008	8.868e-008
o Posterior/Anterior	"	1.074e-008	7.137e-008
o Lateral	"	6.964e-009	4.607e-008
o Rotational	"	9.259e-009	6.144e-008
o Isotropic	"	7.591e-009	5.031e-008

MicroShield v6.02 (6.02-00204)
CEC,_Inc.

Page	:1		
DOS File	:KUSEIR1C.ms6	**File Ref**	:
Run Date	: February 18, 2004	**Date**	:
Run Time	: 1:04:30 PM	**By**	:
Duration	: 00:00:04	**Checked**	:

Case Title: Kaiser Rail Car
Description: Rail Car Crew at 152 Meters
Geometry: 13 - Rectangular Volume

Source Dimensions:

Length	1.6e+3 cm	(52 ft 5.9 in)
Width	289.56 cm	(9 ft 6.0 in)
Height	152.4 cm	(5 ft 0.0 in)

Dose Points

A	X	Y	Z
# 1	16800.2 cm	76.2 cm	144.78 cm
	551 ft 2.3 in	2 ft 6.0 in	4 ft 9.0 in

Shields

Shield N	Dimension	Material	Density
Source	7.06e+07 cm³	FGR12 Soil	1.36
Shield 1	.635 cm	Iron	7.86
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Pb-210	2.2710e-004	8.4027e+006	3.2164e-006	1.1901e-001
Ra-226	4.3307e-004	1.6024e+007	6.1336e-006	2.2694e-001
Ra-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-230	1.8485e-002	6.8395e+008	2.6180e-004	9.6867e+000
Th-232	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000

Buildup : The material reference is - Source
Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Attachment 3

Energy MeV	Activity Photons/sec	Results Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0067	1.214e+02	7.965e-222	2.349e-36	3.659e-222	1.079e-36
0.0108	2.044e+06	2.172e-217	6.404e-32	5.227e-218	1.541e-32
0.0117	1.285e+05	1.480e-218	4.363e-33	2.771e-219	8.170e-34
0.0123	1.868e+07	2.260e-216	6.665e-31	3.618e-217	1.067e-31
0.0123	5.766e+07	6.977e-216	2.057e-30	1.117e-216	3.293e-31
0.0123	1.640e+07	1.984e-216	5.850e-31	3.176e-217	9.364e-32
0.0465	3.403e+05	3.485e-18	3.041e-17	1.077e-20	9.402e-20
0.059	3.713e+05	2.633e-14	4.321e-13	5.347e-17	8.772e-16
0.0677	2.551e+06	3.585e-12	7.625e-11	6.273e-15	1.334e-13
0.0811	2.888e+04	5.534e-13	1.510e-11	8.715e-16	2.378e-14
0.0838	4.797e+04	1.323e-12	3.749e-11	2.063e-15	5.845e-14
0.0844	2.364e+06	7.026e-11	2.006e-09	1.093e-13	3.122e-12
0.0949	2.175e+04	1.920e-12	6.108e-11	2.938e-15	9.349e-14
0.125	8.207e+04	4.280e-11	1.476e-09	6.743e-14	2.326e-12
0.1316	2.423e+05	1.634e-10	5.604e-09	2.605e-13	8.932e-12
0.1681	4.714e+05	9.093e-10	2.850e-08	1.541e-12	4.828e-11
0.1725	2.244e+05	4.787e-10	1.479e-08	8.164e-13	2.522e-11
0.1862	5.256e+05	1.491e-09	4.391e-08	2.588e-12	7.625e-11
0.216	4.670e+05	2.240e-09	5.898e-08	4.018e-12	1.058e-10
0.3097	1.069e+03	1.662e-11	3.099e-10	3.165e-14	5.902e-13
Totals	**1.026e+08**	**5.419e-09**	**1.558e-07**	**9.445e-12**	**2.709e-10**

MicroShield v6.02 (6.02-00204)
CEC,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\CaseFiles\KUSEIR1C.ms6
Case Title: Kaiser Rail Car
This case was run on Wednesday, February 18, 2004 at 1:04:30 PM
Dose Point # 1 - (16800.2,76.2,144.78) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	2.913e-008	8.457e-007
Photon Energy Fluence Rate	MeV/cm²/sec	5.419e-009	1.558e-007
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	9.445e-012	2.709e-010
Absorbed Dose Rate in Air	mGy/hr	8.245e-014	2.365e-012
"	mrad/hr	8.245e-012	2.365e-010
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.163e-013	3.342e-012
o Opposed	"	7.406e-014	2.124e-012
o Rotational	"	7.403e-014	2.123e-012
o Isotropic	"	6.811e-014	1.954e-012
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.163e-013	3.343e-012
o Opposed	"	1.034e-013	2.967e-012
o Rotational	"	1.034e-013	2.967e-012
o Isotropic	"	7.328e-014	2.103e-012
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	1.007e-013	2.896e-012
o Posterior/Anterior	"	8.216e-014	2.360e-012
o Lateral	"	5.382e-014	1.544e-012
o Rotational	"	7.101e-014	2.039e-012
o Isotropic	"	5.839e-014	1.676e-012

Attachment 4

MicroShield v6.02 (6.02-00204)
CEC,_Inc.

Page	:1	**File Ref**	:
DOS File	:KUSEIR1E.ms6	**Date**	:
Run Date	: February 18, 2004	**By**	:
Run Time	: 1:09:14 PM	**Checked**	:
Duration	: 00:00:03		

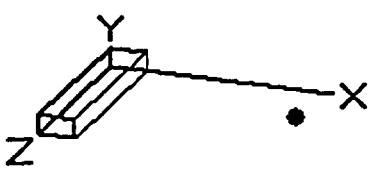
Case Title: Kaiser Rail Car
Description: Rail Employee at 15 Meters
Geometry: 13 - Rectangular Volume

Source Dimensions:

Length	289.56 cm	(9 ft 6.0 in)
Width	1.6e+3 cm	(52 ft 5.9 in)
Height	152.4 cm	(5 ft 0.0 in)

Dose Points

A	X	Y	Z
# 1	1789.56 cm	76.2 cm	800.1 cm
	58 ft 8.6 in	2 ft 6.0 in	26 ft 3.0 in



Shields

Shield N	Dimension	Material	Density
Source	7.06e+07 cm³	FGR12 Soil	1.36
Shield 1	.635 cm	Iron	7.86
Air Gap		Air	0.00122

Source Input : Grouping Method - Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Pb-210	2.2710e-004	8.4027e+006	3.2164e-006	1.1901e-001
Ra-226	4.3307e-004	1.6024e+007	6.1336e-006	2.2694e-001
Ra-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-228	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000
Th-230	1.8485e-002	6.8395e+008	2.6180e-004	9.6867e+000
Th-232	5.2814e-003	1.9541e+008	7.4801e-005	2.7676e+000

Buildup : The material reference is - Source
Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Energy MeV	Activity Photons/sec	Results Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0465	3.403e+05	1.591e-11	9.820e-11	4.921e-14	3.036e-13
0.059	3.713e+05	1.031e-08	9.038e-08	2.092e-11	1.835e-10
0.0677	2.551e+06	6.171e-07	5.870e-06	1.080e-09	1.027e-08
0.0811	2.888e+04	4.583e-08	4.369e-07	7.219e-11	6.880e-10
0.0838	4.797e+04	9.864e-08	9.325e-07	1.538e-10	1.454e-09
0.0844	2.364e+06	5.125e-06	4.836e-05	7.976e-09	7.526e-08
0.0949	2.175e+04	1.011e-07	9.103e-07	1.547e-10	1.393e-09
0.125	8.207e+04	1.253e-06	9.542e-06	1.974e-09	1.503e-08
0.1316	2.423e+05	4.358e-06	3.213e-05	6.947e-09	5.121e-08
0.1681	4.714e+05	1.611e-05	1.024e-04	2.729e-08	1.734e-07
0.1725	2.244e+05	8.134e-06	5.093e-05	1.387e-08	8.684e-08
0.1862	5.256e+05	2.247e-05	1.348e-04	3.901e-08	2.340e-07
0.216	4.670e+05	2.690e-05	1.488e-04	4.826e-08	2.670e-07
0.3097	1.069e+03	1.185e-07	5.416e-07	2.257e-10	1.032e-09
Totals	**7.740e+06**	**8.533e-05**	**5.357e-04**	**1.470e-07**	**9.178e-07**

MicroShield v6.02 (6.02-00204)
CEC,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\CaseFiles\KUSEIR1E.ms6
Case Title: Kaiser Rail Car
This case was run on Wednesday, February 18, 2004 at 1:09:14 PM
Dose Point # 1 - (1789.56,76.2,800.1) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	5.045e-004	3.327e-003
Photon Energy Fluence Rate	MeV/cm²/sec	8.533e-005	5.357e-004
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	1.470e-007	9.178e-007
Absorbed Dose Rate in Air	mGy/hr	1.284e-009	8.013e-009
"	mrad/hr	1.284e-007	8.013e-007
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.843e-009	1.162e-008
o Opposed	"	1.155e-009	7.219e-009
o Rotational	"	1.153e-009	7.202e-009
o Isotropic	"	1.067e-009	6.684e-009
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	1.842e-009	1.161e-008
o Opposed	"	1.613e-009	1.008e-008
o Rotational	"	1.613e-009	1.008e-008
o Isotropic	"	1.146e-009	7.170e-009
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	1.595e-009	1.004e-008
o Posterior/Anterior	"	1.294e-009	8.121e-009
o Lateral	"	8.417e-010	5.267e-009
o Rotational	"	1.116e-009	7.000e-009
o Isotropic	"	9.157e-010	5.739e-009

Attachment 5
RESRAD Summary Report – 21 Pages

Summary : RESRAD Res Farmer - Kaiser Waste at USEI
File : CEC_Kaiser_USEI_Res_farm.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: TGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(1)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(2)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(3)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(1)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(2)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(3)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(6)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(4,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	8.822E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.360E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	5.43DE+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+03	3.000E+02	---	T(7)
R011	Times for calculations (yr)	not used	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pb-210	1.180E+00	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	2.260E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Ra-228	2.800E+01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Th-228	2.800E+01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-230	9.625E+01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Th-232	2.800E+01	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Pb-210	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	3.600E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.780E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-04	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.360E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	3.160E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	7.500E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.840E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	6.700E+00	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	7.000E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	6.100E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.896E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.706E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.706E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.166E-08	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.166E-08	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.166E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+02	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	EMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.300E+01	4.500E+01	---	STOR_T(9)
RN21	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR1
RN21	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
RN21	Total porosity of the cover material	4.130E-01	4.000E-01	---	TPCV
RN21	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
RN21	Volumetric water content of the cover material	2.650E-02	5.000E-02	---	PH2OCV
RN21	Volumetric water content of the foundation	3.000E-02	3.000E-02	---	PH2OFL
RN21	Diffusion coefficient for radon gas (m/sec):				
RN21	in cover material	7.233E-07	2.000E-06	---	DIFCV
RN21	in foundation material	3.000E-07	3.000E-07	---	DIFFL
RN21	in contaminated zone soil	-1.000E+00	2.000E-06	5.471E-07	DIFCZ
RN21	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
RN21	Average building air exchange rate (1/hr)	1.500E+00	5.000E-01	---	REXG
RN21	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
RN21	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
RN21	Building depth below ground surface (m)	-1.000E+00	-1.000E+00	code computed (time dependent)	DMFL
RN21	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
RN21	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	active
Find peak pathway doses	active

Summary : RESRAD Res Farmer - Kaiser Waste at USEI
File : CEC_Kaiser_USEI_Res_farm.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	88221.00 square meters	Pb-210	1.180E+00
Thickness:	33.60 meters	Ra-226	2.260E+00
Cover Depth:	3.60 meters	Ra-228	2.800E+01
		Th-228	2.800E+01
		Th-230	9.625E+01
		Th-232	2.800E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03
TDOSE(t):	2.357E-01	2.398E-01	2.569E-01	2.780E-01	3.626E-01	1.485E+00	4.250E+00
M(t):	9.427E-03	9.593E-03	1.027E-02	1.112E-02	1.451E-02	5.938E-02	1.700E-01

Maximum TDOSE(t): 4.250E+00 mrem/yr at t = 1.000E+03 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.123E-22	0.0000	0.000E+00	0.0000	2.333E-01	0.9909	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	3.307E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.792E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.836E-24	0.0000	0.000E+00	0.0000	2.155E-03	0.0091	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.383E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.137E-19	0.0000	0.000E+00	0.0000	2.357E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.333E-01	0.9909
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.307E-20	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.792E-19	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.155E-03	0.0091
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.383E-21	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.357E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.124E-22	0.0000	0.000E+00	0.0000	2.334E-01	0.9731	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	8.053E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.249E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	3.111E-24	0.0000	0.000E+00	0.0000	6.461E-03	0.0269	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	8.490E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.146E-19	0.0000	0.000E+00	0.0000	2.398E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.334E-01	0.9731
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.053E-20	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.249E-19	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.461E-03	0.0269
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.490E-21	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.398E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.128E-22	0.0000	0.000E+00	0.0000	2.332E-01	0.9078	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	1.220E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	2.947E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.146E-23	0.0000	0.000E+00	0.0000	2.369E-02	0.0922	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	6.338E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.151E-19	0.0000	0.000E+00	0.0000	2.569E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.332E-01	0.9078
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.220E-19	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.947E-20	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.369E-02	0.0922
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.338E-20	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.569E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.134E-22	0.0000	0.000E+00	0.0000	2.328E-01	0.8374	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	8.426E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	4.847E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	2.202E-23	0.0000	0.000E+00	0.0000	4.520E-02	0.1626	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.273E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.166E-19	0.0000	0.000E+00	0.0000	2.780E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.328E-01	0.8374
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.426E-20	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.847E-21	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.520E-02	0.1626
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.273E-19	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.780E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.157E-22	0.0000	0.000E+00	0.0000	2.315E-01	0.6383	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	8.425E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-229	3.549E-24	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	6.558E-23	0.0000	0.000E+00	0.0000	1.312E-01	0.3617	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.139E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.225E-19	0.0000	0.000E+00	0.0000	3.626E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.315E-01	0.6383
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.425E-21	0.0000
Th-229	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.549E-24	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.312E-01	0.3617
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.139E-19	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.626E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.523E-22	0.0000	0.000E+00	0.0000	2.140E-01	0.1441	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	9.044E-22	0.0000	0.000E+00	0.0000	1.271E+00	0.8559	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.188E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.196E-19	0.0000	0.000E+00	0.0000	1.485E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.140E-01	0.1441
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.271E+00	0.8559
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.188E-19	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.485E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	3.104E-22	0.0000	0.000E+00	0.0000	1.747E-01	0.0411	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	7.242E-21	0.0000	0.000E+00	0.0000	4.076E+00	0.9589	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	8.115E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	8.191E-19	0.0000	0.000E+00	0.0000	4.250E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.747E-01	0.0411
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.076E+00	0.9589
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.115E-19	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.250E+00	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	Ra-226	1.000E+00	1.033E-01	1.033E-01	1.032E-01	1.030E-01	1.024E-01	9.468E-02	7.730E-02
Ra-226	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	ΣDSR(j)		1.033E-01	1.033E-01	1.032E-01	1.030E-01	1.024E-01	9.468E-02	7.730E-02
Ra-228	Ra-228	1.000E+00	1.015E-24	9.009E-25	5.596E-25	3.086E-25	2.856E-26	3.169E-40	0.000E+00
Ra-228	Th-228	1.000E+00	1.180E-21	2.875E-21	4.356E-21	3.009E-21	3.009E-22	3.138E-36	0.000E+00
Ra-228	ΣDSR(j)		1.181E-21	2.876E-21	4.356E-21	3.009E-21	3.009E-22	3.139E-36	0.000E+00
Th-228	Th-228	1.000E+00	6.398E-21	4.460E-21	1.052E-21	1.731E-22	1.267E-25	0.000E+00	0.000E+00
Th-230	Th-230	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	Ra-226	1.000E+00	2.238E-05	6.713E-05	2.461E-04	4.696E-04	1.363E-03	1.320E-02	4.235E-02
Th-230	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	ΣDSR(j)		2.238E-05	6.713E-05	2.461E-04	4.696E-04	1.363E-03	1.320E-02	4.235E-02
Th-232	Th-232	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-232	Ra-228	1.000E+00	6.240E-26	1.779E-25	5.258E-25	7.852E-25	1.100E-24	1.723E-24	5.157E-24
Th-232	Th-228	1.000E+00	4.933E-23	3.030E-22	2.270E-21	4.547E-21	7.637E-21	1.138E-20	2.898E-20
Th-232	ΣDSR(j)		4.940E-23	3.032E-22	2.271E-21	4.548E-21	7.638E-21	1.138E-20	2.898E-20

*Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03
Pb-210	*7.631E+13	*7.631E+13	*7.631E+13	*7.631E+13	*7.631E+13	*7.631E+13	*7.631E+13
Ra-226	2.419E+02	2.421E+02	2.423E+02	2.427E+02	2.441E+02	2.640E+02	3.234E+02
Ra-228	*2.726E+14	*2.726E+14	*2.726E+14	*2.726E+14	*2.726E+14	*2.726E+14	*2.726E+14
Th-228	*8.192E+14	*8.192E+14	*8.192E+14	*8.192E+14	*8.192E+14	*8.192E+14	*8.192E+14
Th-230	1.117E+06	3.724E+05	1.016E+05	5.324E+04	1.835E+04	1.894E+03	5.904E+02
Th-232	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05

*At specific activity limit

Summary : RESRAD Res Farmer - Kaiser Waste at USEI
File : CEC_Kaiser_USEI_Res_farm.RAD

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 1.000E+03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pb-210	1.180E+00	0.000E+00	0.000E+00	*7.631E+13	0.000E+00	*7.631E+13
Ra-226	2.260E+00	0.000E+00	1.033E-01	2.419E+02	7.730E-02	3.234E+02
Ra-228	2.800E+01	4.098 ± 0.008	4.423E-21	*2.726E+14	0.000E+00	*2.726E+14
Th-228	2.800E+01	0.000E+00	6.398E-21	*8.192E+14	0.000E+00	*8.192E+14
Th-230	9.625E+01	1.000E+03	4.235E-02	5.904E+02	4.235E-02	5.904E+02
Th-232	2.800E+01	1.000E+03	2.898E-20	*1.096E+05	2.898E-20	*1.096E+05

*At specific activity limit

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	Ra-226	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	Th-230	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	∑DOSE(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	Ra-226	1.000E+00	2.335E-01	2.334E-01	2.332E-01	2.328E-01	2.315E-01	2.140E-01	1.747E-01
Ra-226	Th-230	1.000E+00	2.155E-03	6.461E-03	2.369E-02	4.520E-02	1.312E-01	1.271E+00	4.076E+00
Ra-226	∑DOSE(j)		2.357E-01	2.398E-01	2.569E-01	2.780E-01	3.626E-01	1.485E+00	4.250E+00
Ra-228	Ra-228	1.000E+00	2.841E-23	2.522E-23	1.567E-23	8.642E-24	7.997E-25	0.000E+00	0.000E+00
Ra-228	Th-232	1.000E+00	1.747E-24	4.981E-24	1.472E-23	2.199E-23	3.080E-23	4.824E-23	1.444E-22
Ra-228	∑DOSE(j)		3.016E-23	3.020E-23	3.039E-23	3.063E-23	3.160E-23	4.824E-23	1.444E-22
Th-228	Ra-228	1.000E+00	3.304E-20	8.050E-20	1.220E-19	8.425E-20	8.424E-21	0.000E+00	0.000E+00
Th-228	Th-228	1.000E+00	1.792E-19	1.249E-19	2.947E-20	4.847E-21	3.549E-24	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	1.381E-21	8.485E-21	6.356E-20	1.273E-19	2.138E-19	3.187E-19	8.114E-19
Th-228	∑DOSE(j)		2.136E-19	2.139E-19	2.150E-19	2.164E-19	2.223E-19	3.187E-19	8.114E-19
Th-230	Th-230	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-232	Th-232	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	1.180E+00	1.144E+00	1.010E+00	8.646E-01	4.642E-01	1.046E-04	3.669E-14
Pb-210	Ra-226	1.000E+00	0.000E+00	6.915E-02	3.249E-01	6.023E-01	1.359E+00	1.997E+00	1.447E+00
Pb-210	Th-230	1.000E+00	0.000E+00	6.413E-04	1.538E-02	5.848E-02	4.351E-01	1.048E+01	3.239E+01
Pb-210	∑S(j):		1.180E+00	1.214E+00	1.350E+00	1.525E+00	2.259E+00	1.248E+01	3.383E+01
Ra-226	Ra-226	1.000E+00	2.260E+00	2.259E+00	2.255E+00	2.250E+00	2.229E+00	1.969E+00	1.426E+00
Ra-226	Th-230	1.000E+00	0.000E+00	4.169E-02	2.082E-01	4.160E-01	1.242E+00	1.167E+01	3.326E+01
Ra-226	∑S(j):		2.260E+00	2.301E+00	2.463E+00	2.666E+00	3.471E+00	1.364E+01	3.468E+01
Ra-228	Ra-228	1.000E+00	2.800E+01	2.482E+01	1.532E+01	8.385E+00	7.520E-01	5.467E-15	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	3.180E+00	1.267E+01	1.961E+01	2.724E+01	2.799E+01	2.799E+01
Ra-228	∑S(j):		2.800E+01	2.800E+01	2.800E+01	2.800E+01	2.799E+01	2.799E+01	2.799E+01
Th-228	Ra-228	1.000E+00	0.000E+00	7.988E+00	1.611E+01	1.145E+01	1.126E+00	8.193E-15	0.000E+00
Th-228	Th-228	1.000E+00	2.800E+01	1.949E+01	4.575E+00	7.475E-01	5.328E-04	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	5.220E-01	7.315E+00	1.580E+01	2.687E+01	2.799E+01	2.799E+01
Th-228	∑S(j):		2.800E+01	2.800E+01	2.800E+01	2.800E+01	2.799E+01	2.799E+01	2.799E+01
Th-230	Th-230	1.000E+00	9.625E+01	9.625E+01	9.625E+01	9.624E+01	9.622E+01	9.599E+01	9.538E+01
Th-232	Th-232	1.000E+00	2.800E+01	2.800E+01	2.800E+01	2.800E+01	2.800E+01	2.800E+01	2.800E+01

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 4.00 seconds