40-6940

CABOT

June 7, 2000

U.S. Nuclear Regulatory Commission
Ms. Leslie Fields
2 White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

RE: LICENSE SMB-920

Dear Ms. Fields:

Cabot proposes to transfer certain of its process and other solid wastes containing less than 0.05w% (weight percent) of source material from its Boyertown, Pennsylvania, plant to Waste Control Specialists' (WCS) facility located in Andrews, Texas, in accordance with 10 CFR Part 40.13, "Unimportant Quantities of Source Material". An evaluation of potential radiological dose that might result from such disposition has been prepared by WCS and Cabot. Estimates of dose to members of the public are less than 25 mrem/yr. Thus, the evaluation demonstrates that the potential dose to members of the public as a consequence of the propose waste disposal will be substantially less than 100 mrem/hr.

Cabot believes that the proposed disposal will satisfy our mutual interests in disposing of waste safely and in accordance with applicable regulations. Cabot will appreciate it if you will confirm the acceptability of this proposed disposition of waste as soon as you reasonably can.

If you have any questions or comments about the enclosed analysis, please contact me at 610-369-8520.

Sincerely,
CABOT PERFORMANCE MATERIALS

Timothy M. Knapp
Radiation Safety Officer

Enclosure

/car
NRC-SMB-920-060700.tmk

Cabot Performance Materials
P.O. Box 1608
County Line Road
Boyertown, Pennsylvania 19512-1608
Phone: 610-367-2181

NMSS01 Public

ANALYSIS OF DISPOSAL OF UNIMPORTANT QUANTITY OF SOURCE MATERIAL AT WCS ANDREWS FACILITY

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1. DESCRIPTION OF THE WCS ANDREWS FACILITY

1.1. ENVIRONMENTAL

Waste Control Specialists' Andrews facility is located in the extreme western part of Andrews County, Texas, adjacent the border with New Mexico. The location is also about 30 miles east of the USDOE Waste Isolation Pilot Plant facility. The closest communities to the facility are the city of Andrews and the city of Eunice. The city of Andrews (1990 population 10,678) is approximately 30 miles east of the facility and is the major population center for Andrews County (1990 population was 14,338). The city of Eunice (1990 population was 2676) is located 6 miles west of the facility within the State of New Mexico. There is no residential area, school, day care center, highway rest area, or national monument within a five mile radius of the facility. The facility is located on a 15,215 acre site (1500 acres in New Mexico), 1338 acres of which are fully permitted for the treatment, storage and disposal of RCRA and TSCA wastes (The permits allow acceptance of all RCRA and TSCA waste codes). The currently permitted disposal area can accommodate more than 11,000,000 cubic yards of waste.

The climate at the facility is classified as being arid to semi-arid and characterized by hot summers and dry winters. The average yearly total precipitation is approximately 14 inches, while the average yearly evaporation rate is approximately 63.25 inches per year. The prevailing winds from December to May are toward the north or south with wind velocities above 18 knots only 5 percent of the time. The wind speed increases from March to May to approximately 12 percent above 18 knots and the wind direction slightly increases toward the South. During the months of June to November, the wind direction is predominantly to the south with wind velocity greater than 18 knots only 5 percent of the time. Tornadoes pose a natural threat to many areas in Texas. However, the probability of a tornado impacting a building at the facility appears to be very unlikely since Andrews County is in the area of lowest level of occurrence in Texas, and there is no record of a tornado in Andrews County. During the winter months, snow and icy conditions are possible, since the average monthly low temperature from November to February is below 32 degrees. However, as with most areas in Texas, snow and ice does not remain for extended periods of time, thereby limiting its effect on the facility. Normal operations at the facility are expected to continue throughout the winter months.

The Andrews site sits on an ancient erosional feature called the Redbed Ridge. This ridge is composed of a thick (about 800 to 1,000 foot) layer of continuous, predominately low permeability (about 10^{-8} to 10^{-9} cm/sec) red-bed clay, called the Dockum formation, that comes to within about 12 to 40 feet of the surface at the site. Migration times through this natural barrier have been conservatively calculated to be greater than 150,000 years. This clay layer protects the only aquifer at the site, the Santa Rosa Sandstone located below the clay formation, from any infiltration of water from the surface. The Santa Rosa aquifer is at least 900 feet below the surface, contains high levels of TDS, and is considered to be non-potable. None of the rainfall that falls on the site now, and probably none of the rainfall that has fallen on the site during the entire Pleistocene and Holocene geologic time periods,

has reached the Santa Rosa aquifer.

Surface deposits at the site, identified as the Antlers, Caprock Caliche, and Blackwater Draw Formations, are about 12 to 40 feet thick and consist primarily of eolian sand, caliche and a thin sand and gravel deposit at the base of the caliche. The high ratio of annual evapotranspiration to precipitation combined with the waste cell design[1] will preclude significant hydrogeologic transport from the cells to the surficial deposits even after the engineered cover (15 foot thick compacted clay with other engineered barriers) has hypothetically degraded.

Sandy and silty lenses in the upper part of the Dockum formation, appear to be isolated hydrogeologically and have been observed to exhibit very low rates of diffusive flow. The high iron oxide clays are expected to be very effective sorbents of radionuclides. These isolated sandy and silty lenses are unlikely to result in any transport of radionuclides off-site. At about 200 feet below the surface there is a layer of sand and silt that is saturated. But wells drilled into this layer are non-productive; consequently, it is not classified as an aquifer. Due to its low permeability, this layer serves as a ground water monitoring zone. Site monitoring wells drilled into this layer serve as an excellent, natural warning system for migration.

The Dockum surface is a smooth, gently rolling eroded surface which contains shallow depressions called "buffalo wallows". The only water wells in the vicinity of the site are shallow wells, which tap into these shallow depressions and tend to collect water after a large precipitation event. These shallow wells contain high TDS, are typically pumped by windmill, and the water is only used for livestock watering or process water. The shallow formation is not classified as an aquifer.

There is no surface water or wetland anywhere near the Andrews facility. The nearest potable groundwater aquifer is the Ogallala aquifer, which is located at least 10 miles northeast of the site and on the opposite side of the Redbed ridge. Potable water for site use is piped in from west of Hobbs, NM, about 20 miles northwest of the site.

The only commercial activities within the vicinity of the facility consist of oilwell penetrations and a gravel and crushing operation located approximately 1 mile to the west of the facility. Adjacent land use is not expected to change during the active life of the facility. These activities will have no adverse impact upon the facility.

The following additional analyses have been performed on Andrews site:

- An evaluation has been performed with respect to its stability against potential seismic and fault activity. These studies show that there are no faults within the survey area with displacements in the Holocene time, and a review of probabilistic earthquake acceleration maps indicate that the project site does not fall within a seismic impact

[1] Waste cell design includes removal of the surface deposits, excavation into the redbed clay, construction of a 10 foot sidewall natural clay layer above the Dockum to the surface, and the RCRA engineered barriers

zone.

- An analysis has been performed to determine the effects of the 100 year flood with a conclusion that the 100 year flood has no effect upon the facility.
- An analysis has been performed to assess the potential for long term erosion at the site. Utilizing the highest estimated erosion rates, it is extremely unlikely (if not impossible) that the WCS facility could be breached by erosion within the next 25,000 to 50,000 years, and more likely in excess of 100,000 years. The WCS facility is situated atop a prominent buried ridge (Redbed), which has not been breached by erosion and has been a stable topographic feature, persisting as a drainage divide for at least the past 11 to 13 million years.
- An archeological survey was conducted with the results indicating that no cultural artifacts worthy of site designation were found and that the study area offered few enticements to prehistoric people or early settlers.
- An ecological study has been performed which has determined that there are no threatened or endangered species present at the site.

The nearest population center to the site is the town of Eunice more than five miles west of the site. Eunice has no municipal well; instead it brings water by pipe from Hobbs, New Mexico, more than twenty miles northwest of the site. There is no municipal well nearer to the site than those at Hobbs.

1.2. FACILITY DESIGN AND OPERATION

All waste currently authorized for disposal is placed in a RCRA cell with double plastic and clay liners and a double leachate collection system. The bottom of this cell extends well into the natural clay formation. An additional ten feet of compacted clay has been placed under the sidewall double liner from the surface down to the natural redbed clay, which provides an additional natural barrier for lateral migration near the surface.

The WCS Andrews facility has received a radioactive waste storage and treatment license from the Texas Health Department. This license allows for the long term storage of hundreds of thousands of curies of various radionuclides for the term of the license, which is currently seven years and renewable. Storage capability includes pre-packaged and treated low level waste and mixed waste, including greater than Class C waste and sealed sources, in a drum storage facility that can accommodate 5,000 drums (36,750 cubic feet) and a bin storage area that can accommodate about 262,000 cubic feet of waste.

The treatment facility includes a state of the art treatment/stabilization building, half of which is for treatment and stabilization of a variety of RCRA and TSCA wastes, with the remaining half dedicated to the treatment of radioactive and mixed waste. The current low-level radioactive waste (LLRW) treatment capabilities include consolidation, repackaging, stabilization of mixed waste, capabilities for in-drum compaction, and a variety of other waste management services. Current hazardous waste treatment capabilities include consolidation, repackaging, and stabilization for a wide variety of RCRA and TSCA wastes. The TSCA permit uniquely allows the direct disposal of PCB contaminated materials and/or treatment, if necessary.

In view of the radioactive waste storage and treatment license, all operations involving the handling of any radioactive material are performed under the existing radiation safety program, regardless of the exemption status of the materials to be disposed or handled. All on site personnel are trained and badged as radiation workers. All work on site involving handling of radioactive material is controlled by specific procedures and an approved Radiation Work Permit (RWP). All site design, operations and record keeping activities are controlled under a Quality Assurance Program

A comprehensive environmental monitoring program is being conducted under the requirements of the various existing RCRA/TSCA permits and radioactive material license.

All material will be shipped to the WCS site in DOT approved containers or will meet DOT bulk shipping requirements. A shipping manifest will be prepared to document and certify the contents of the packages. The shipping manifest will be used to certify that all waste packages contain only radionuclides that meet the limits specified in TRCR Part 40 and unimportant concentration criteria in 10 CFR Part 40.13. After receipt survey are performed, random samples may be taken on suspect packages based on external surveys, to verify compliance with all waste acceptance requirements.

Exempt level material that does not contain RCRA or TSCA regulated materials, or meets the RCRA requirements for disposal will be transported directly to the WCS onsite RCRA/TSCA disposal cell for final disposition. The WCS RCRA/TSCA permit allows disposal of radioactive material that is exempt from licensing under particular laws and regulations, and is therefore not classified as low level radioactive waste. Once received, the material will not leave the WCS licensed facility and will be handled only by appropriately trained WCS radiation workers and WCS transport vehicles under an approved radiation work permit.

Exempt level material containing RCRA materials that require treatment will be stored temporarily in the transport containers in approved buildings awaiting staging for treatment and then moved to the Stabilization building for treatment and/or stabilization to meet the land disposal restrictions (LDR) prior to disposal. Treatment will be performed in accordance with the radiation safety program. Again, the material will not leave the WCS facility and will be handled only by appropriately trained WCS radiation workers and WCS transport vehicles under an approved radiation work permit.

The current RCRA requirements applicable to the WCS facility exceed the Part 61 requirements in several areas related to design and institutional control. This includes: a minimum of 30 versus 5 years for active maintenance, deed restrictions which prevent disturbing the cover after the facility has been closed, a 5 meter engineered cover which satisfies the Part 61 intruder barrier requirement for Class C waste, and a double lined-double leachate collection system RCRA engineered cell. There is no requirement under RCRA for long term government ownership.

Existing site permits and licenses require various financial assurance instruments that provide for site decommissioning and closure, site maintenance and monitoring after closure, liability protection, and cleanup and removal of all waste stored on site under the

license, if WCS cannot perform this activity.

The radiation dose to the general public from all facility operations will be maintained below all applicable radiation protection limits and ALARA, and is expected to be far less than 1 mrem/yr. The radiation dose to workers will also be maintained below applicable limits and ALARA for all facility operations. All work will be performed under the existing radiation safety program and procedures. All workers are badged and trained as radiation workers. With these practices, radiological dose to workers from treatment and disposal of exempt level material is expected to be less than the standard for members of the public.

2. SAFETY ANALYSIS FOR DISPOSAL OF EXEMPT MATERIAL AT THE WCS ANDREWS FACILITY

2.1. PROTECTION OF WORKERS DURING OPERATIONS

WCS is committed to operations that are in compliance with the standards for protection against radiation as established in 25 TAC 289.202 and standard industry practices. These criteria for operation are specified in the WCS Radiological Control Manual and the implementing procedures for radiation safety which have been previously described. The requirements for operation in these manuals are imparted to the workers and visitors through the training programs in the Radiological Training Manual. All work on site involving handling of radioactive material will be in accordance with the Operating Procedures Manual that embraces and implements the radiological safety program. All on site personnel are trained and badged as radiation workers.

In order to assess the impact to workers from the transport, receipt, processing, and disposal of unimportant quantities of source material, an analysis was performed using the TSD-DOSE computer program, version 2.22. TSD-DOSE is a program developed by Argonne National Laboratory for estimating doses to facility workers and the surrounding public at Treatment, Storage, and Disposal (TSD) facilities from shipments of hazardous waste which may contain small amounts of radionuclides.

TSD-DOSE can estimate worker and public doses from seven operations. Each of these operations can be evaluated, or not, to reflect the actual TSD facility operations. Many of the parameters used to model the typical operations may be adjusted to fit the WCS facility. A radiological dose is calculated for each operation based on waste characteristics, including radionuclide concentration, and site-specific information entered by the user. Doses to various receptors are calculated by summing the doses from those operations that would potentially contribute to the exposure.

The TSD-DOSE computer program[2] was used to calculate the dose to the truck driver and WCS facility workers during transport and handling of the exempt level material. Default values in TSD-DOSE were used except for the following:

- Waste volume is a 20 yard roll-off container.
- Incoming density was assumed to be 1.4 g/cm^3.

[2] TSD-DOSE, version 2.2, September 1998.

- The incineration model was not evaluated.

The results of the TSD-DOSE model calculations are shown Attachment 1. Since all workers at WCS are trained and badged as radiation workers, the 1 mrem/yr limit can be exceeded under Texas Department of Health license to WCS.

Radiological dose to WCS workers was evaluated in two waste handling scenarios. In one scenario, waste containing 0.05 wt% source material was assumed to be received and deposited directly into a RCRA landfill cell. Exposure was estimated during waste transport, receiving, and deposit into the landfill. TSD-DOSE derivations for this scenario are in Table 1.

Table 1. Radiological Dose When Waste is Deposited Directly Into Landfill

Radionuclide	Concentration	Radiological Dose to Person Exposed			
		Driver	Receiving Worker	Landfill Worker	Person Offsite
	(pCi/g waste)	(mrem)	(mrem)	(mrem)	(mrem)
U^{238} +d	167	1.9 e-02	2.7 e-03	3.3 e-04	5.8 e-06
U^{234}	167	1.7 e-05	1.2 e-03	9.7 e-07	6.4 e-06
Th^{230}	167	1.0 e-04	2.9 e-03	3.4 e-06	1.6 e-05
Ra^{226} +d	167	1.7 e+00	1.4 e-01	3.1 e-02	3.9 e-06
	Total Dose	1.7e+00	1.5e-01	3.1e-02	3.2e-05
Th^{232}	54.5	8.2 e-06	4.9 e-03	4.2 e-07	2.6 e-05
Ra^{228} +d	54.5	3.1 e-01	2.6 e-02	5.6 e-03	2.1 e-07
	Total Dose	3.1e-01	3.1e-02	5.6e-03	2.6e-05

The best, single-valued estimate of uranium to thorium radioactivity in Cabot waste is approximately 3.6-to-1. The concentrations corresponding to 0.05 wt% source material of 3.6 U-to-1 Th are 90 pCi U^{238}/g and 25 pCi Th^{232}/g. When this mixture of uranium series and thorium series in waste is evaluated, the resulting estimate of total dose is in Table 2.

Table 2. Radiological Dose When Waste is Deposited Directly Into Landfill

Radionuclide	Concentration	Radiological Dose to Person Exposed			
		Driver	Receiving Worker	Landfill Worker	Person Offsite
	(pCi/g waste)	(mrem)	(mrem)	(mrem)	(mrem)
U^{238} +d	90	1.0 E-02	1.5 E-03	1.8 E-04	3.1 E-06
U^{234}	90	9.2 E-06	6.5 E-04	5.2 E-07	3.4 E-06
Th^{230}	90	5.4 E-05	1.6 E-03	1.8 E-06	8.6 E-06
Ra^{226} +d	90	9.2 E-01	7.5 E-02	1.7 E-02	2.1 E-06
Th^{232}	25	3.8 E-06	2.2 E-03	1.9 E-07	1.2 E-05
Ra^{228} +d	25	1.4 E-01	1.2 E-02	2.6 E-03	9.6 E-08
	Total Dose	1.1 E+00	9.3 E-02	1.9 E-02	2.9 e-05

In another scenario, waste containing 0.05 wt% source material was assumed to be treated before deposit into a RCRA landfill cell. Exposure was estimated during transport to WCS, receiving the waste, storage, treatment, and deposit into the landfill. TSD-DOSE derivations for this scenario are in Table 3.

Table 3. Radiological Dose When Waste is Treated and Deposited Into Landfill

Radionuclide	Concentration	Radiological Dose to Person Exposed			
		Driver	Receiving Worker	Landfill Worker	Person Offsite
	(pCi/g waste)	(mrem)	(mrem)	(mrem)	(mrem)
U^{238}+d	167	1.9 e-02	5.9 e-02	7.2 e-03	5.8 e-06
U^{234}	167	1.7 e-05	5.4 e-03	7.3 e-03	6.4 e-06
Th^{230}	167	1.0 e-04	1.4 e-02	1.8 e-02	1.6 e-05
Ra^{226} +d	167	1.7 e-00	4.7 e-00	6.5 e-02	3.9 e-06
	Total Dose	1.7e+00	4.8e+00	9.8e-02	3.2e-05
Th^{232}	54.5	8.2 e-06	2.2 e-02	3.0 e-02	2.6 e-05
Ra^{228} +d	54.5	3.1 e-01	8.5 e-01	1.1 e-02	2.1 e-07
	Total Dose	3.1e-01	8.7e-01	4.1e-02	2.6e-05

When a radioactivity mixture of 3.6 uranium to 1 thorium in waste is evaluated, the resulting estimate of total dose is in Table 4.

Table 4. Radiological Dose When Waste is Treated and Deposited Into Landfill

Radionuclide	Concentration	Radiological Dose to Person Exposed			
		Driver	Receiving Worker	Landfill Worker	Person Offsite
	(pCi/g waste)	(mrem)	(mrem)	(mrem)	(mrem)
U^{238} +d	90	1.0 E-02	3.2 E-02	3.9 E-03	3.1 E-06
U^{234}	90	9.2 E-06	2.9 E-03	3.9 E-03	3.4 E-06
Th^{230}	90	5.4 E-05	7.5 E-03	9.7 E-03	8.6 E-06
Ra^{226} +d	90	9.2 E-01	2.5 E+00	3.5 E-02	2.1 E-06
Th^{232}	25	3.8 E-06	1.0 E-02	1.4 E-02	1.4 E-05
Ra^{228} +d	25	1.4 E-01	3.9 E-01	5.9 E-03	1.1 E-07
	Total Dose	1.1 E+00	3.0 E+00	7.5 E-02	3.1 E-05

Although Cabots' waste is not expected to require treatment at WCS, that contingency would result in the maximum estimated dose to a WCS receiving worker who treats the waste. A *receiving worker* or a *landfill worker* is a radiation worker, subject to the occupational limit in WCSs' radioactive material license.

The maximum potential exposure estimate to a member of the public during disposal would be to a trucker while hauling waste. According to these estimates, a single driver could haul about 100 loads before his potential dose reaches 100 mrem. But because Cabot plans to ship its waste by rail, not by truck, the estimated dose to a trucker is unlikely to occur.

The potential dose to workers during operations was also evaluated at the bounds of the uranium series –to- thorium series ratios. Worker scenarios were evaluated under separate assumptions that 1)uranium series only is present at 0.05 wt% (*i.e.*, 167 pCi U^{238}/g) and 2) thorium series only is present at 0.05 wt% (*i.e.*, 54.5 pCi Th^{232}/g). Results of the analyses, in Tables 1 and 3 show that, at any U –to- Th ratio in which the sum does not exceed 0.05 wt%, the potential dose to the most exposed category of worker, a receiving worker, is estimated to be 0.9 to 4.8 mrem. At any U –to- Th ratio, the most a truck driver, would experience would be 0.3 to 1.7 mrem. It seems unlikely that any particular driver would haul enough loads, all at the maximum acceptable radioactivity concentration, to experience as much as 25 mrem.

2.2. DOSE TO THE GENERAL PUBLIC DURING FACILITY OPERATIONS

2.2.1. Operation.

Releases of radioactivity in effluents to the general environment are maintained at release levels below the allowable limits and as low as reasonable achievable through the implementation of an effective radiation control program. Appropriate design features are incorporated into the disposal cell design, operation, and closure to help achieve this goal include but are not limited to, a multi-layer thick disposal cell cover system, leachate collection system, long term maintenance specifications, and RCRA financial assurance.

Processing of radioactive waste material occurs inside enclosed buildings where there are precautions to prevent or reduce airborne radioactivity. Containers of radioactive waste materials are opened under controlled conditions. Bins containing bulk materials are kept covered.

During operation, effluents and radiation fields are monitored. The entire facility is surrounded by a restricted buffer area of approximately 1 mile. The nearest industrial area is located more than 1 mile to the west of the facility and winds toward that direction occur less than 5 percent of the time.

Wastewater is not discharged from the facility. There is no connection to a municipal sewer system. Radioactive wastewater is collected in a storage container for use in stabilization processes or processed through the radioactive wastewater treatment system. Treated water is reused in the facility. Should the treated water exceed WCS requirements, upon approval by the Andrews Waterworks Department, it may be transferred via tank truck to the Andrews sanitary sewer system.

The radiological dose to members of the public from the facility operations is expected to be far less than 1 millirem per year. Estimates derived with TSD-DOSE models to a person off-site, tabulated in Tables 2 and 4 are practically zero.

2.2.2. Accident.

In order to assess the impacts from a worst case operational accident involving exempt level material, an analysis was performed in the Environmental Analysis for a Class C Radioactive Waste Processing and Storage License (Reference 8). This analysis assumes a totally destructive fire in the bin storage area. Thirty-six bins of waste, each bin containing 800 ft^3, (total volume 28,800 ft^3) were assumed to be in storage and totally destroyed by the fire. Calculated doses for radionuclides of interest are tabulated below.

Nuclide	Activity Density Ci/ft^3	Activity Concentration pCi/gm	Radiological Dose			
			1000 m (mrem)	At 2000 m (mrem)	At 3000 m (mrem)	At 5000 m (mrem)
U-238	2.7 e-05	750.	6.07	2.95	1.95	1.19
U-238	6.0 e-06	166.5	(1.34)	(0.65)	(0.43)	(0.26)

(Extrapolated values for exempt levels are shown in parentheses.)

This analysis is a upper bound for accidents on-site. (The analysis for a worst case tornado event produced nearly identical impacts.) This analysis is a very conservative estimate since most exempt level waste will be received in a non-combustible soil/debris matrix and it is extremely unlikely that all material in storage would be at the maximum exempt concentration limit.

2.3. PROTECTION OF THE GENERAL PUBLIC AFTER SITE CLOSURE

In the operation of the facility for disposal of exempt level material, WCS is committed to ensuring that concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals shall not result in an annual dose above background exceeding an equivalent of 1 millirem effective whole body dose to of any member of the public after site closure.

WCS has prepared a bounding analysis that assesses releases to the general environment from the disposal of unimportant concentration of source material[3] after disposal site closure. An analysis using the RESRAD computer code (V 5.95) has been performed to demonstrate that unimportant quantities of source material can be disposed at the WCS facility without exceeding a 1 mrem/yr effective dose to the maximum exposed individual.

2.3.1. 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 scenario most likely to maximize radiation exposure. Use of

[3] 10 CFR Part 40.13

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 5-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--ingrowth 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
9. Radon (water dependent)
   -Release of radon gas from groundwater brought into residence--ingrowth of airborne particulate radon daughter products--inhalation
10. 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
11. 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

2.3.2. Parameters.

Some values of parameters in RESRAD were entered specifically describing the WCS Andrews site.

The calculations include an analysis using the HELP model to estimate infiltration through the disposal cell cover. That analysis takes no credit for the geotextile, HPDE liner, asphalt, and bottom soil layer. The infiltration through the cover is conservatively calculated to be less than 0.00028 m/yr. These infiltration results are used in the RESRAD model to estimate radiological dose.

An analysis also has been performed using a conservative mathematical model to estimate the transport time to the nearest aquifer, the Santa Rosa at about 1000 feet below the site. Since the infiltration rate is very low, the bottom of the disposal cell is more than 50% into the clay layer, and the presence of the 10 foot compacted clay layer along the sides of the cell; transport is assumed only to occur in a vertical direction down through the clay. This analysis shows that the minimum travel time through the thick clay layer below the site, assuming K_d=0 for all radionuclides, is about 183,000 years.

A detailed analysis has been performed to estimate potential radiation exposure from radioactive gases emanating through the cover system. As before, no credit is taken for geotextile, HPDE liner, asphalt, and bottom soil layer. The results of this analysis show that it would require the disposal of over 100,000 curies of Ra-226, Th-230, U-234, or U-238 to result in greater than 1 mrem/yr exposure to a worker directly on top of a disposal cell. Disposal of exempt level material will never begin to approach these inventories. Assuming 1000 pCi/gm, it would require about 10^8 m^3 of waste to create an inventory of 100,000 curies, which is about ten times greater than the currently permitted disposal capacity.

The following assumptions were made in developing input data for the RESRAD

analysis.

- Even though erosion analysis indicates that it is likely that the cover depth will increase over time, cover erosion rate was conservatively calculated using the USDA's universal soil loss equation: $A = R*K*L_s*C*P$. For an established final cover; R=90 (for Western Andrews Co), K =0.27 (for sandy clay loam-conservative since most of cover is hard compacted clay), L_s=0.4 (for L =300 ft, s =3%), C =0.01 (for moderate, grass legume meadow), and P =1.0 (for no supportive practice for long term); so A =0.0972 tons/acre/yr ≈0.01 yd^3/acre/yr = 1.83×10^{-6} m/yr.
- The cover depth is assumed to be 5 meters of clay with no credit taken for any engineered layers or barriers.
- Since the infiltration rate is very low, the bottom of the disposal cell is more than 50% into the redbed clay formation, and there is a 10 foot compacted clay layer along the sides of the cell to the surface, the permeability is assumed to be the same as was measured from drillings in the Dockum Formation. The permeability of the Dockum has been measured to be between 10^{-9} and 10^{-8} cm/sec, so a value of about 3×10^{-9} cm/sec (≈1×10^{-3} m/yr) was chosen as the unsaturated zone hydraulic conductivity. An unsaturated zone thickness of 300 m (981 ft) was used since the Dockum is reported to be between 800 to 1100 ft thick.
- Other values such as annual rainfall (0.355m), cover porosity (0.427), and cover volumetric water content (0.418) for calculation of radon diffusion rate are actual site data.
- The evapotranspiration coefficient was conservatively assumed to be 0.8. For purposes of sensitivity analysis, the calculated infiltration from the HELP model was used to calculate the evapotranspiration coefficient using Equation E.4 in the RESRAD manual as follows: $I=(1-C_e)[(1-C_r)P_r+I_{rr}]$. For the WCS condo disposal cell; I=2.74E-04 m/yr, C_r=0.5, P_r=0.355 m/yr and I_{rr}=0, so C_e=0.9985.
- Other values used for the RESRAD calculations are default values.

2.3.3. Radioactive Source Term.

Key, long-lived radionuclides in each of the uranium series and thorium series were entered in RESRAD in concentration corresponding to 0.05 wt %. Radioactivity concentrations entered were

Key Radionuclide	Concentration (pCi/g)
U^{238}	166.5
U^{235}	1.2
U^{234}	166.5
Th^{230}	166.5
Ra^{226}	166.5
Th^{232}	54.5

Having entered the equivalent of 0.05 wt % of each series, the source term is overestimated by a factor of 2. Over the 1000 years simulated, short-lived radioactive progeny grow to radioactive equilibrium with their parent radionuclides.

2.3.4. Results.

Detailed results of the RESRAD calculations are in Attachment 2. The maximum potential radiological dose to an hypothetical future resident farmer on the WCS Andrews site from all exposure pathways is estimated by RESRAD to be zero within the next 1000 years.

Sensitivity calculations have also been performed as follows:

- If the waste volume is assumed to increase one hundred times, the dose remains insignificant.
- If the evapotranspiration coefficient is increased to 0.8, the dose from all radionuclides remains insignificant.

2.3.4.1. Waste from Cabot.

The best estimate of uranium to thorium radioactivity in Cabot waste is approximately 3.6-to-1. The concentrations corresponding to 0.05 wt% source material of 3.6 U-to-1 Th are 90 pCi U^{238}/g and 25 pCi Th^{232}/g. The resulting estimate of total dose to a farmer residing on the WCS site after closure from this mixture of uranium series and thorium series in waste would be practically zero within the next 1000 years.

3. EVALUATION OF INADVERTENT INTRUSION SCENARIO

3.1. INTRODUCTION

Facility design and operation include appropriate features to protect against intrusion into the WCS facility. These measures include but are not limited posted warning signs, a fence around the property boundary, and security guards to prevent intrusion onto the facility.

WCS intends make a reasonable effort to protect against inadvertent intrusion into the disposal site, occupation of the site, or human contact with the waste at any time after active institutional controls over the disposal site are removed. Planned controls after site closure include a 5 meter-thick, engineered cover of compacted clay. Deed restrictions will prohibit excavation.

Because of the presence of the 5 meter-thick, compacted clay cover, the only intrusion scenario of potential concern is believed to be drilling to try to establish a water well. Radiological dose was estimated to a person who intrudes into buried waste by entering the burial site after its closure and drills through buried waste while trying to establish a water well. The result of the drilling intrusion analysis is that the radionuclide concentration in buried waste necessary to exceed 1 mrem/yr would be in excess of 10^6 pCi/cm^3. These concentrations are far in excess of approximately 115 pCi/g corresponding to 0.05 wt% source material mixture in Cabot waste.

Calculation of external exposure from exhumed waste was based on the guidance document IMPACTS (NUREG/CR-4370, 1986). The waste exhumed by drilling was assumed to be collected in a pit with the drilling cuttings and drilling fluid. The drilling

was estimated to occur for 8 hours a day for three days; thus, the intruder was assumed to be exposed to the radiation for 24 hours. After drilling, the pit is assumed to be filled to the top with soil from the surrounding area. Inhalation impacts are discounted because of the liquid nature of the contaminated mud would suppress dust and mitigate inhalation.

Initial computations estimates potential exposure from unit radionuclide concentrations of 1.0 Ci/m^3 disposed of in the Main Landfill and the Condo Landfills. Because waste exhumation is a concentration scenario, results are presented in units of mrem·m^3/Ci·yr. The estimated radiological dose compute per unit concentration of each radionuclide was subsequently scaled to the radionuclide concentration equivalent to 0.05 wt% source material.

3.2. METHODOLOGY

3.2.1. Exposure Scenario

At the end of the institutional control period, 100 years after site closure, it is possible, although unlikely, that an intruder might build a house on or near the landfill. In order to secure a supply of water for living needs, a well is assumed to be drilled to the Santa Rosa aquifer. The drilling crew is assumed to drill inadvertently through the landfill and exhume a quantity of waste, which is presumed to be diverted into a pit with the drilling cuttings. The drilling crew is assumed to be exposed to the waste for the duration of the drilling, a total of 24 hours (8 hr/day for 3 days).

3.2.2. Source

Waste containing as much as 0.05 wt% source material is assumed to be buried in the engineered landfill cell penetrated by drilling. In the nominal mixture of uranium series and thorium series in waste at Cabot, 3.6-to-1 by radioactivity, the concentrations corresponding to 0.05 wt% source material are 90 pCi U^{238}/g and 25 pCi Th^{232}/g waste.

3.2.3. Equations Used for Calculation of Exposure from Unit Concentration

Potential exposure to a unit waste concentration was estimated with the following equation:

$$H_{j,k} = R_j \cdot f_D \cdot DF_k \qquad (1)$$

where $H_{j,k}$ = exposure from unit concentration (mrem-m^3/Ci-yr)
R_j = exposure rate (mrem-m^3/Ci-hr)
f_D = exposure duration factor (24 hr/yr)
DF_k = dilution factor
j = radionuclide j
k = landfill k

The exposure duration factor (f_D) was assumed to be 24 hr/yr based on the 24 hr drilling time. The dilution factor (DF_k) accounts for the mixing of the exhumed waste with the drilling cuttings in the pit and is calculated in section 3.2.4. The exposure rate (R_j) was calculated based on guidance provided in section 4.2.1 of IMPACTS (NUREG/CR-4370, 1986), dose conversion factors listed in Federal Guidance Document No. 12 (FGR 12, 1993),

and gamma ray energies provided in the computer model RADDECAY 2.02 (Grove Engineering, 1987).

3.2.4. Dilution Factor

Drilling cuttings consisting of exhumed waste were assumed to be completely mixed with cuttings from the remainder of the drilling. Assuming that the cuttings settle to the bottom of the drill mud pit and the drilling fluid (water) overlies the cuttings, the radionuclide concentration in the cuttings can be calculated as follows:

$$DF_k = \frac{V_{waste}}{V_{shaft}} = \frac{T_k}{T_H + T_k} \qquad (2)$$

where V_{waste} = volume of waste exhumed by drilling (m^3)
V_{shaft} = total volume of well shaft (m^3)
T_k = thickness of waste in landfill (m)
T_H = thickness of soils between landfill and aquifer (m)

Equation 2 is valid for a constant well hole diameter, assumed to be 8 inches. The soil thickness (T_H) was estimated to be 330 m based on the geotechnical report. The thicknesses of the Main Landfill is 78 feet, and subtracting 5 meters for the thickness of the cap yields a waste thickness of 18.8 meters. The thickness of the Condo Landfills is 65 feet, and subtracting 5 meters for the cap yields a waste thickness of 14.6 meters. Thus, the dilution factor (DF_k) was calculated to be 0.0538 and 0.0430 for the Main Landfill and Condo Landfills, respectively. The value of T_H does not include the thickness of the landfill cover systems, therefore calculation of the dilution factor is conservative.

3.2.5. Exposure Rate

The exposure rate was calculated based on site specific characteristics and methods described in Section 4.2.1 of IMPACTS and Section 3.1 of NUREG/CR-3585 (1985). The exposure rate is given by Equation 3, which accounts for shielding provided by water overlaying the exhumed waste, the finite size of the cuttings pit, and decay and ingrowth of radionuclides over time.

Equation 3 provides correction for several important physical phenomena. Decay of parent and ingrowth of progeny radionuclides was accounted for by summing the dose conversion factors for each radionuclide in a decay chain. The activity ratio ($AR_{j,i}$) is the ratio of radionuclide parent or progeny activity after 100 years of decay to the initial concentration of the parent radionuclide. The shielding provided by the layer of drilling fluid overlying the exhumed waste was accounted for by the shielding factor (SF_i). The finite, rectangular shape of the pit was accounted for by the areal exposure correction factor (CF_i).

$$R_j = \sum_{i=0}^{n} AR_{j,i} \cdot DCF_i \cdot CF_i \cdot SF_i \qquad (3)$$

where DCF_i = dose conversion factor (mrem-m^3/Ci-hr)
SF_i = shielding factor provided by water
Cf_i = areal exposure correction factor

$AR_{j,i}$ = activity ratio, i=0 for parent
n = number of radionuclides in decay chain including parent
i = progeny or parent radionuclide *i* present after decay period

3.2.5.1. Dose Conversion Factors

The does conversion factors (DCF) are based on FGR 12[4], Table III.7, factors for exposure to soil contaminated to an infinite depth. The factors in Table III.7, when multiplied by 1.33 x 10^{19}, convert from Sv-m^3/Bq-s to mrem-m^3/Ci-hr. For many of the radionuclides, these DCF are conservative because they include exposure from both gamma rays and beta particles even though no beta particles could penetrate the water that overlays the waste. Additionally, these DCF include Bremsstrahlung radiation caused by deceleration of beta particles.

Preliminary calculations show that for radionuclides with multiple progeny in their decay chains, over 95% of the exposure rate results from only one, two, or three of the radionuclides in the decay chain. As a simplification, exposure from the other radionuclides that contribute less then 5% to the total exposure rate was not calculated.

3.2.5.2. Areal Exposure Correction Factors

The dose factors in Table III.7 of FGR 12 are for a source with infinite area, therefore an areal correction factor (CF_i) was used to account for the finite size of the drill mud pit. Based on Section 3.1 of NUREG/CR-3585 (1985), the shape correction factor is given by the following equation:

$$CF_i = \frac{A_{pit}}{A_{cir}} CF_{circle,i} = \frac{A_{pit}}{A_{circle}} \left(1 - \frac{E_1\left(\mu_{a,i}\sqrt{z^2 + r^2}\right)}{E_1(\mu_{a,i} z)} \right) \quad (4)$$

where

A_{pit} = area of drill mud pit (m^2)
R = maximum horizontal distance from a person to an element of the source
Z = maximum vertical distance from a person to an element of the source
A_{circle} = area of circle with radius equal to the maximum distance from a person to an element of the source (m^2)
$CF_{circle,i}$ = correction factor for a person located a distance z above a source of radius *r*
$E_1(x)$ = exponential integral of x (calculated using a Taylor series approximation (Jeffrey, 1995))
$\mu_{a,I}$ = linear attenuation coefficient of air (m^{-1})

The pit containing the cuttings and drilling fluid was assumed to be rectangular in shape and the cuttings were assumed to be shielded by an overlying layer of drilling fluid

[4] USEPA. *External Exposure to Radionuclides in Air, Water, and Soil.* Fed. Guidance Rpt. No 12. EPA 402-R-93-081. Sept. 93.

(water). The cuttings were assumed to be completely mixed with exhumed waste (the initial portion of these cuttings). That is, drill cuttings settle to the bottom of the pit and the drilling water rises to the surface. IMPACTS suggests that the volume of the pit should be three times the volume of the cuttings.

Slightly fewer cuttings would be exhumed by drilling through the Condo Landfills than the Main Landfill; therefore, slightly less water would shield the exhumed waste. For this reason, the source/shield geometry of the Condo Landfill was more conservative and was used to calculate R_j (which was used for both the Main Landfill and the Condo Landfills). For the Condo Landfills, the volume of the cuttings were calculated to be 11.1 m^3, thus the total volume of cuttings and drilling fluid was assumed to be 33.3 m^3. The pit was assumed to be 17 ft (5.2 m) on each side and 5 ft (1.52 m) deep. The dose point was assumed to be 1.0 m above the top of the pit. This results in a source (cuttings) thickness of 0.41 m and shield thicknesses of 0.83 m of water.

Given that the mud pit was 5.2 m on each side, r = 5.2 m, A_{pit} = 27 m^2, and, A_{circle} = 84 m^2. The dose point was assumed to be 1.0 m above the top of the pit and there is 0.3 m of air between the surface of the water and the top of the pit ;therefore z = 1.3 m. The mass attenuation coefficients in air, as a function of gamma ray energy in MeV, are taken from page 139 of the Radiological Health Handbook (1970). These values are given in units of cm^2/g. An air density of 0.00122 g/cm^3 was assumed, thus the values were multiplied by 0.122 to convert to units of m^{-1}.

Because attention coefficients are given for each gamma ray rather than for each radionuclide, it was assumed that all gamma rays for a single radionuclide penetrate identically to the most energetic gamma ray emitted by that radionuclide. This is a very conservative assumption because in reality the DCF are dependent on the entire range of gamma rays emitted by a radionuclide but the lower energy gamma rays are more attenuated than the higher energy ones.

For some radionuclides, there is a higher yield (probability of emission) for a gamma ray that is slightly lower in energy than the maximum energy gamma ray. In order to be more reflective of reality for these instances, the gamma ray with the higher yield and slightly lower energy was used instead of the gamma with the lower yield and maximum energy. This was done for U-235, for instance.

3.2.5.3. Shielding Factors

The 0.83 m of water estimated to overlay the exhumed waste in drill mud shields against radiation. This thickness of water completely blocks alpha and beta particles but is not sufficient to completely block high energy gamma rays. Therefore, following formula from IMPACTS was used to calculate the gamma ray shielding factor:

$$SF_i = e^{-\mu_{w,i}L} B(\mu_{w,i}L) = e^{-\mu_{w,i}L}(1 + 0.95\mu_{w,i}L + 0.35(\mu_{w,i}L)^2) \qquad (5)$$

where $\mu_{w,i}$ = linear attenuation coefficient for gamma in water (m^{-1})
L = thickness of water layer (0.83 m)
B(x) = polynomial buildup factor

The mass attenuation coefficients in water were taken from page 138 of the Radiological Health Handbook (1970). These values are given in units of cm^2/g, and an water density of 1.0 g/cm^3 was assumed. Therefore, the values were multiplied by 100 to convert to units of m^{-1}.

3.2.5.4. Activity Ratios

A number of radionuclides, such as U^{234}, have both short-lived and long-lived progeny. In order to properly calculate exposure from these nuclides it was necessary to account for exposure due to the progeny as well as the parent. Ingrowth and decay of radionuclides was calculated using the following formula:

$$AR_{j,i} = \frac{A_i}{A_j} = \prod_{a=1}^{n} \lambda_a \sum_{b=0}^{n} \frac{e^{-t\lambda_b}}{\prod_{\substack{c=0 \\ c \neq b}} (\lambda_c - \lambda_b)} \qquad (6)$$

where A_i = activity of progeny/parent at time t (Ci)
A_j = activity of parent at time 0 (Ci)
λ_x = decay constant for radionuclide x (yr^{-1})
j = parent radionuclide
i = daughter or parent radionuclide (i=0 for parent; i=n for final daughter)
n = number or radionuclides in decay chain including parent

Each radionuclide was analyzed separately. The source was assumed to have an initial concentration of 1.0 Ci/m^3 for each parent radionuclide analyzed. The activity of the parents and the progeny were calculated after 100 years of decay and ingrowth.

A 100-year time frame was evaluated because intrusion was assumed to occur 100 years after the closure of the landfill. This assumes that all the radionuclides were assumed to be placed in the landfill during the last year of operational waste acceptance.

3.2.6. Summary of Parameters Used to Estimate Potential Exposure

Equations 1 through 6 can be used to estimate the potential exposure from a unit concentration of 1.0 Ci/m^3 in either landfill via the intruder-driller scenario. Parameters used in these equations are summarized in Table 5.

Table 5. Summary of Parameters

Parameter	Symbol	Main Landfill	Condo Landfills
Exposure duration factor (hr/yr)	f_D	24	24
Waste thickness in landfill (m)	T_k	18.8	14.6
Depth of well shaft (m)	T_H	330	330
Dilution factor	DF_k	0.0538	0.0430
Rate of exposure	R_k	Radionuclide specific	
Activity ratio	$AR_{j,i}$	Radionuclide specific	
Dose conversion factor	DCF_i	Radionuclide specific	
Vertical source-intruder distance (m)	z	1.28	1.28
Horizontal source-intruder distance (m)	r	5.28	5.28
Gamma attenuation in air	$\mu_{a,i}$	Radionuclide specific	
Areal exposure correction factor	CF_i	Radionuclide specific	
Thickness of water shield (m)	L	0.83	0.83
Gamma attenuation in water	$\mu_{w,i}$	Radionuclide specific	
Shielding factor for water	SF_i	Radionuclide specific	

3.3. Results of Inadvertent Intrusion Analysis

The driller-intruder analyses incorporated site parameters, federal guidance documents, geotechnical reports, and other sources of information to determine the potential exposure from radionuclides disposed of in the landfills.

The estimated unit exposure from 1.0 Ci/m^3 of each key U series and Th series radionuclide was calculated. Decay chain calculations were performed so that exposure rates for radionuclides includes the activities of progeny present after 100 years of institutional control. The analysis estimated the potential exposure from a unit radionuclide activity of 1.0 Ci/m^3 disposed of in the Main Landfill and the Condo Landfills. Parent radionuclides analyzed are listed in Table 6. An estimate of potential exposure from a unit concentration of 1.0 Ci/m^3 of each was calculated for both landfills and is also shown in Table 6.

Table 6. Potential Intruder-Driller Exposure from Unit Activity in Each Landfill

Radionuclide	Unit Source in Main Landfill (mrem·m³/yr·Ci)	Unit Source in Condo Landfills (mrem·m³/yr·Ci)
Ra-226	1.9E+1[a]	1.5E+1[a]
Ra-228	2.1E-4	1.7E-4
Th-230	8.5E-1	6.8E-1
Th-232	2.7E+1	2.2E+1
U-234	3.9E-4	3.1E-4
U-235	5.9E-3	4.7E-3
U-238	1.1E-1	8.5E-2

[a] exposure due to Rn-222 and radioactive progeny of Rn-222.

The unit exposure rates in Table 6 were multiplied by the maximum radionuclide concentration in the projected inventory to yield an estimate of the exposure rate for each radionuclide. The projected concentrations and exposure rates are shown in Table 7. Since this scenario applies to one intrusion episode, the acute exposure standard should be 500 mrem/yr.

The specific focus of the analysis of intrusion is the scenario under which a person enters the closed landfill site after the end of institutional control and drills a well to the aquifer below the landfill.

To estimate potential exposure, spreadsheet calculations were carried out for the intruder-driller scenario described in IMPACTS. The calculations estimated external exposure to gamma radiation from exhumed waste. The exhumed waste was assumed to be collected in a pit with the drilling cuttings and drilling fluid. The drilling was estimated to occur for 8 hours a day for three days, thus the intruder was assumed to be exposed to the radiation for 24 hours. Site parameters were based on a number of sources including landfill design drawings, geophysical analyses of the site and surrounding area, and federal regulatory guidance documents such as IMPACTS.

Table 7. Potential Intruder-Driller Exposure from Projected Maximum Concentration in Each Landfill

Radionuclide	Maximum Concentration		Main Landfill Potential Exposure	Condo Landfill Potential Exposure
	(pCi/g)	(Ci/m^3)	(mrem)	(mrem)
Ra^{226}	90	1.2e-04	2.2e-03	1.8e-03
Ra^{228}	25	3.3e-05	6.8e-09	5.5e-09
Th^{230}	90	1.2e-04	9.9e-05	8.0e-05
Th^{232}	25	3.3e-05	8.8e-04	7.2e-04
U^{234}	90	1.2e-04	4.6e-08	3.6e-08
U^{235}	0.64	8.3e-07	4.9e-09	3.9e-09
U^{238}	90	1.2e-04	1.3e-05	9.9e-06
		Total dose	3.2e-03	2.6e-03

The intruder-driller analysis indicates that exposure from radionuclides will be far below the standard of 500 mrem/yr for an acute exposure and below the 100 mrem/yr standard for chronic exposure. There is a considerable margin of safety associated with this estimate because it assumes that the entire quantity of waste removed by drilling contains the maximum concentration. The waste will be placed in the landfill in layers and it is highly unlikely that a cross sectional core of waste would be homogeneous.

The intruder-driller scenario was also evaluated at the bounds of the uranium series –to- thorium series ratios. Potential intruder-driller exposure was evaluated under separate assumptions of 1)uranium series only is present at 0.05 wt% (*i.e.*, 167 pCi U^{238}/g) and 2) thorium series only is present at 0.05 wt% (*i.e.*, 54.5 pCi Th^{232}/g). Results of the analyses, inTable 8, show that, at any U –to- Th ratio in which the sum does not exceed 0.05 wt%, the potential dose to an hypothetical person who intrudes by drilling into a landfill will experience an estimated 1.6×10^{-3} to 4.3×10^{-3} mrem. Thus, disposal by burying waste not exceeding 0.05 wt% U and or Th at any U –to- Th ratio will be well below 25 mrem.

Table 8. Potential Intruder-Driller Exposure from Projected Maximum Concentration in Each Landfill

Radionuclide	Maximum Concentration		Main Landfill Potential Dose	Condo Landfill Potential Dose
	(pCi/g)	(Ci/m³)	(mrem)	(mrem)
U^{238}	167.	2.2e-04	2.4e-05	2.0e-06
U^{235}	167.	2.2e-04	1.3e-06	1.0e-06
U^{234}	167.	2.2e-04	8.5e-08	6.7e-08
Th^{230}	167.	2.2e-04	1.8e-04	1.5e-04
Ra^{226}	167.	2.2e-04	4.1e-03	3.3e-03
		Total =	4.3e-03	3.4e-03
Th^{232}	54.5	7.1e-05	1.9e-03	1.6e-03
Ra^{228}	54.5	7.1e-05	1.5e-08	1.2e-08
		Total =	1.9e-03	1.6e-03

4. CONCLUSIONS OF ANALYSES

Cabot desires to dispose of soil, building rubble, debris, process equipment, and such wastes arising from its C-T process and supporting facilities in Boyertown, PA by transfer to WCSs' Andrews facility. Cabot will transfer only waste containing no more than 0.05 wt% source material. Estimates of radiological dose to members of the public and to workers were made to evaluate the consequence of disposing of waste containing an unimportant concentration of source material as prescribed in 10 CFR Part 40.13 in a landfill at Waste Control Specialists' facility in Andrews, Texas.

Analyses demonstrate that members of the public are subject to less than 25 mrem/yr potential radiological dose as a consequence of the proposed disposal and at any U series – to- Th series ratio.

- Although Cabot plans to ship the waste by rail; if hauled by truck, a single driver would have to haul about 25 loads before receiving as much as 25 mrem cumulative dose.
- While waste is being disposed in a landfill cell at WCS, potential dose to a member of the public near WCS is estimated to be about 3×10^{-5} mrem/load. Thus, a member of the public will experience much less than 25 mrem/yr from disposal of all waste from Cabot.
- Even in the event of an accidental release, potential dose beyond WCSs' buffer zone is estimated to be only about 1 mrem or less.
- After WCSs' disposal cells are closed and 100 years of institutional control has expired, an hypothetical farmer residing on the site is estimated to experience practically zero potential radiological dose arising from buried waste containing 0.05 wt% source material.

- Even in the postulated event of inadvertent intrusion by drilling into buried waste after institutional control ends, the potential dose is estimated to be only about 3×10^{-3} mrem.

WCS workers are *radiation workers*; and thereby, are subject to Texas state occupational dose standards.

REFERENCES

1. Grove Engineering, Inc. RADDECAY 2.02, Grove Engineering, Inc., Rockville Md, 1987.
2. Jeffrey, A. *Handbook of Mathematical Formulas and Integrals*, Academic Press, San Diego, 1995.
3. U.S. Dept. Health, Education, and Welfare. *Radiological Health Handbook*, compiled and edited by the Bureau of Radiological Health and the Training Institute Environmental Control Administration, Rockville, MD, 1970.
4. U.S. Environmental Protection Agency, *External Exposure to Radionuclides In Air, Water, And Soil*, Federal Guidance Report No. 12, Office of Radiation Programs, EPA-402-R-93-081, Washington, D.C., September 1993.
5. U.S. Environmental Protection Agency, *Draft Environmental Impact Statement for Proposed Rules, Volume 1 Background Information Document. Low-Level and NARM Radioactive Wastes*, EPA 520/1-87-012-1, June 1988.
6. U.S. Nuclear Regulatory Commission, *De Minimis Waste Impacts Analysis Methodology*, NUREG/CR-3585, Vol. 1, 1984.
7. U.S. Nuclear Regulatory Commission, *Update of Part 61 Impacts Analysis Methodology*, NUREG/CR-4370, Vol. 1, 1986.

Attachment 1

TSD-DOSE Analysis for Disposal of Unimportant Quantities of Source Material at the WCS Andrews Facility

Direct Disposal

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (U) direct disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.9E-02 mrem	1.9E-02 mrem	0.0E+00 mrem
Receiving worker:	3.9E-03 mrem	1.7E-03 mrem	2.2E-03 mrem
Incineration worker:	5.3E-06 mrem	5.3E-06 mrem	0.0E+00 mrem
Landfill worker:	3.3E-04 mrem	3.3E-04 mrem	1.4E-06 mrem
Offsite individual:	1.2E-05 mrem		
Offsite population:	4.1E-05 p-rem		
Worker Population:	2.7E-05 p-rem	2.2E-05 p-rem	4.5E-06 p-rem
Dose from:			
Transport to TSD facility:	1.9E-02 mrem	1.9E-02 mrem	not applicable
Receiving and sampling waste:	3.9E-03 mrem	1.7E-03 mrem	2.2E-03 mrem
Storage before processing:	5.3E-06 mrem	5.3E-06 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	3.3E-04 mrem	3.3E-04 mrem	1.4E-06 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	U234	U238+D
Activity	3.3E-03 Ci	3.3E-03 Ci
Release Fraction	5.00E-04	5.00E-04
Driver	1.7 E-05	1.9 E-02
Receiving worker	1.2 E-03	2.7 E-03
Incineration worker	not applicable	
Landfill worker	9.7 E-07	3.3 E-04
Offsite individual	6.4 E-06	5.8 E-06
Offsite population	2.2 E-05	2.0 E-05
Worker population	2.4 E-06	2.4 E-05

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-07 hours

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 1.83E-02 hours
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-05 hours

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-06 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-03 hours

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-05 hours

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-05 hours
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-05 hours
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-06 hours
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (Th-230) direct disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.0E-04 mrem	1.0E-04 mrem	0.0E+00 mrem
Receiving worker:	2.9E-03 mrem	1.3E-05 mrem	2.9E-03 mrem
Incineration worker:	3.8E-08 mrem	3.8E-08 mrem	0.0E+00 mrem
Landfill worker:	3.4E-06 mrem	1.6E-06 mrem	1.8E-06 mrem
Offsite individual:	1.6E-05 mrem		
Offsite population:	5.3E-05 p-rem		
Worker Population:	6.0E-06 p-rem	1.3E-07 p-rem	5.8E-06 p-rem
Dose from:			
Transport to TSD facility:	1.0E-04 mrem	1.0E-04 mrem	not applicable
Receiving and sampling waste:	2.9E-03 mrem	1.3E-05 mrem	2.9E-03 mrem
Storage before processing:	3.8E-08 mrem	3.8E-08 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	3.4E-06 mrem	1.6E-06 mrem	1.8E-06 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Th230
Activity	3.3E-03 Ci 167 pCi/gm
Release Fraction	5.00E-04
Driver	1.0 E-04
Receiving Worker	2.9 E-03
Incineration Worker	not applicable
Landfill Worker	3.4 E-06
Offsite Individual	1.6 E-05
Offsite population	5.3 E-05
Worker population	6.0 E-06

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-07 hours

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 1.83E-02 hours
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-05 hours

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-06 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-03 hours

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-05 hours

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-05 hours
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-05 hours
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 8.00E-06 hours
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (Ra-226) direct disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.7E+00 mrem	1.7E+00 mrem	0.0E+00 mrem
Receiving worker:	1.4E-01 mrem	1.4E-01 mrem	7.7E-05 mrem
Incineration worker:	4.6E-04 mrem	4.6E-04 mrem	0.0E+00 mrem
Landfill worker:	3.1E-02 mrem	3.1E-02 mrem	4.8E-08 mrem
Offsite individual:	3.9E-06 mrem		
Offsite population:	1.3E-05 p-rem		
Worker Population:	2.0E-03 p-rem	2.0E-03 p-rem	1.5E-07 p-rem
Dose from:			
Transport to TSD facility:	1.7E+00 mrem	1.7E+00 mrem	not applicable
Receiving and sampling waste:	1.4E-01 mrem	1.4E-01 mrem	7.7E-05 mrem
Storage before processing:	4.6E-04 mrem	4.6E-04 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	3.1E-02 mrem	3.1E-02 mrem	4.8E-08 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Ra226+D	
Activity	3.3E-03 Ci	167 pCi/gm
Release Fraction	5.00E-04	
Driver	1.7 E+00	
Receiving worker	1.4 E-01	
Incineration worker	not applicable	
Landfill worker	3.1 E-02	
Offsite individual	3.9 E-06	
Offsite population	1.3 E-05	
Worker population	2.0 E-03	

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-07 hours

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 1.83E-02 hours
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-05 hours

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-06 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-03 hours

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-05 hours

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-05 hours
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-05 hours
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-06 hours
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt Thorium- direct disposal
User: domsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	3.1E-01 mrem	3.1E-01 mrem	0.0E+00 mrem
Receiving worker:	3.1E-02 mrem	2.6E-02 mrem	4.9E-03 mrem
Incineration worker:	1.8E-05 mrem	1.8E-05 mrem	0.0E+00 mrem
Landfill worker:	5.6E-03 mrem	5.6E-03 mrem	3.0E-07 mrem
Offsite individual:	2.7E-05 mrem		
Offsite population:	9.0E-05 p-rem		
Worker Population:	3.8E-04 p-rem	3.7E-04 p-rem	9.8E-06 p-rem
Dose from:			
Transport to TSD facility:	3.1E-01 mrem	3.1E-01 mrem	not applicable
Receiving and sampling waste:	3.1E-02 mrem	2.6E-02 mrem	4.9E-03 mrem
Storage before processing:	1.8E-05 mrem	1.8E-05 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	5.6E-03 mrem	5.6E-03 mrem	3.0E-07 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Ra228+D	Th232
Activity	1.1E-03 Ci	1.1E-03 Ci
Release Fraction	5.00E-04	5.00E-04
Driver	3.1 E-01	8.2 E-06
Receiving worker	2.6 E-02	4.9 E-03
Incineration worker	not applicable	
Landfill worker	5.6 E-03	4.2 E-07
Offsite individual	2.1 E-07	2.6 E-05
Offsite population	7.2 E-07	8.9 E-05
Worker population	3.7 E-04	9.8 E-06

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-06 hours

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 1.83E-02 hours
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-05 hours

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-05 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-04 hours

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-05 hours

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E-04 hours
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-06 hours
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-05 hours
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TREATMENT AND DISPOSAL

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (U) treatment and disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.9E-02 mrem	1.9E-02 mrem	0.0E+00 mrem
Receiving worker:	6.5E-02 mrem	5.5E-02 mrem	1.0E-02 mrem
Incineration worker:	4.6E-02 mrem	4.6E-02 mrem	0.0E+00 mrem
Landfill worker:	1.5E-02 mrem	6.9E-04 mrem	1.4E-02 mrem
Offsite individual:	1.2E-05 mrem		
Offsite population:	4.1E-05 p-rem		
Worker Population:	4.4E-04 p-rem	4.0E-04 p-rem	3.4E-05 p-rem
Dose from:			
Transport to TSD facility:	1.9E-02 mrem	1.9E-02 mrem	not applicable
Receiving and sampling waste:	1.9E-02 mrem	8.5E-03 mrem	1.0E-02 mrem
Storage before processing:	4.6E-02 mrem	4.6E-02 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	1.5E-02 mrem	6.9E-04 mrem	1.4E-02 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	U234	U238+D
Activity	3.3E-03 Ci	3.3E-03 Ci
Release Fraction	5.00E-04	5.00E-04
Driver	1.7 E-05	1.9 E-02
Receiving worker	5.4 E-03	5.9 E-02
Incineration worker	not applicable	
Landfill worker	7.3 E-03	7.2 E-03
Offsite individual	6.4 E-06	5.8 E-06
Offsite population	2.2 E-05	2.0 E-05
Worker population	1.9 E-05	4.2 E-04

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-01 hours (D)
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (Th-230) treatment and disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.0E-04 mrem	1.0E-04 mrem	0.0E+00 mrem
Receiving worker:	1.4E-02 mrem	3.9E-04 mrem	1.3E-02 mrem
Incineration worker:	3.3E-04 mrem	3.3E-04 mrem	0.0E+00 mrem
Landfill worker:	1.8E-02 mrem	3.4E-06 mrem	1.8E-02 mrem
Offsite individual:	1.6E-05 mrem		
Offsite population:	5.3E-05 p-rem		
Worker Population:	4.7E-05 p-rem	2.9E-06 p-rem	4.5E-05 p-rem
Dose from:			
Transport to TSD facility:	1.0E-04 mrem	1.0E-04 mrem	not applicable
Receiving and sampling waste:	1.3E-02 mrem	6.7E-05 mrem	1.3E-02 mrem
Storage before processing:	3.3E-04 mrem	3.3E-04 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	1.8E-02 mrem	3.4E-06 mrem	1.8E-02 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Th230
Activity	3.3E-03 Ci 167 pCi/gm
Release Fraction	5.00E-04
Driver	1.0 E-04
Receiving worker	1.4 E-02
Incineration worker	not applicable
Landfill worker	1.8 E-02
Offsite individual	1.6 E-05
Offsite population	5.3 E-05
Worker population	4.7 E-05

Site Description

Operations Included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 6.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-01 hours (D)
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (Ra-226) treatment and disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.7E+00 mrem	1.7E+00 mrem	0.0E+00 mrem
Receiving worker:	4.7E+00 mrem	4.7E+00 mrem	3.5E-04 mrem
Incineration worker:	4.0E+00 mrem	4.0E+00 mrem	0.0E+00 mrem
Landfill worker:	6.5E-02 mrem	6.4E-02 mrem	4.8E-04 mrem
Offsite individual:	3.9E-06 mrem		
Offsite population:	1.3E-05 p-rem		
Worker Population:	3.5E-02 p-rem	3.5E-02 p-rem	1.2E-06 p-rem
Dose from:			
Transport to TSD facility:	1.7E+00 mrem	1.7E+00 mrem	not applicable
Receiving and sampling waste:	7.1E-01 mrem	7.1E-01 mrem	3.5E-04 mrem
Storage before processing:	4.0E+00 mrem	4.0E+00 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	6.5E-02 mrem	6.4E-02 mrem	4.8E-04 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Ra226+D
Activity	3.3E-03 Ci 167 pCi/gm
Release Fraction	5.00E-04
Driver	1.7 E+00
Receiving worker	4.7 E+00
Incineration worker	not applicable
Landfill worker	6.5 E-02
Offsite individual	3.9 E-06
Offsite population	1.3 E-05
Worker population	3.5 E-02

Site Description

Operations Included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.60E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-01 hours (D)
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill
average distance: 5.00E+00 feet (D)
duration: 2.60E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 5.00E+00 feet (D)
duration: 2.60E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: exempt source (Th) treatment and disposal
User: dornsife

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	3.1E-01 mrem	3.1E-01 mrem	0.0E+00 mrem
Receiving worker:	8.7E-01 mrem	8.5E-01 mrem	2.2E-02 mrem
Incineration worker:	7.2E-01 mrem	7.2E-01 mrem	0.0E+00 mrem
Landfill worker:	4.2E-02 mrem	1.1E-02 mrem	3.0E-02 mrem
Offsite individual:	2.7E-05 mrem		
Offsite population:	9.0E-05 p-rem		
Worker Population:	6.4E-03 p-rem	6.3E-03 p-rem	7.5E-05 p-rem
Dose from:			
Transport to TSD facility:	3.1E-01 mrem	3.1E-01 mrem	not applicable
Receiving and sampling waste:	1.5E-01 mrem	1.3E-01 mrem	2.2E-02 mrem
Storage before processing:	7.2E-01 mrem	7.2E-01 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	4.2E-02 mrem	1.1E-02 mrem	3.0E-02 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	Ra228+D	Th232
Activity	1.1E-03 Ci	1.1E-03 Ci
Release Fraction	5.00E-04	5.00E-04
Driver	3.1 E-01	8.2 E-06
Receiving worker	8.5 E-01	2.2 E-02
Incineration worker	not applicable	
Landfill worker	1.1 E-02	3.0 E-02
Offsite individual	2.1 E-07	2.6 E-05
Offsite population	7.2 E-07	8.9 E-05
Worker population	6.3 E-03	7.5 E-05

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Storage before processing
Burial at onsite landfill

Operations excluded:

Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.3 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 1.80E+01 feet
width: 7.50E+00 feet
height: 5.00E+00 feet

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 3.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 2.80E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 2.00E+00 feet (D)
duration: 1.60E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 2.00E+00 hours (D)
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 5.00E+00 feet (D)
duration: 1.00E+00 hours (D)

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 1.67E-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 8.33E-02 hours (D)

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)

Step B: Transfer solids out
average distance: 3.00E+00 feet (D)
time per drum or pallet: 8.33E-02 hours (D)

Step C: Workers in liquid waste storage area
average distance: 3.00E+00 feet (D)
duration: 6.00E+01 hours (D)
shielding thickness: 1.25E-01 inches (D)
Storage tank dimensions:
length: 7.00E+00 feet (D)
width: 7.00E+00 feet (D)
height: 1.20E+01 feet (D)

Burial at onsite landfill (4 steps)

Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 5.00E-01 hours (D)
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Burial at onsite landfill (cont'd)

Step C: Load truck and transport to landfill

average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill

average distance: 5.00E+00 feet (D)
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

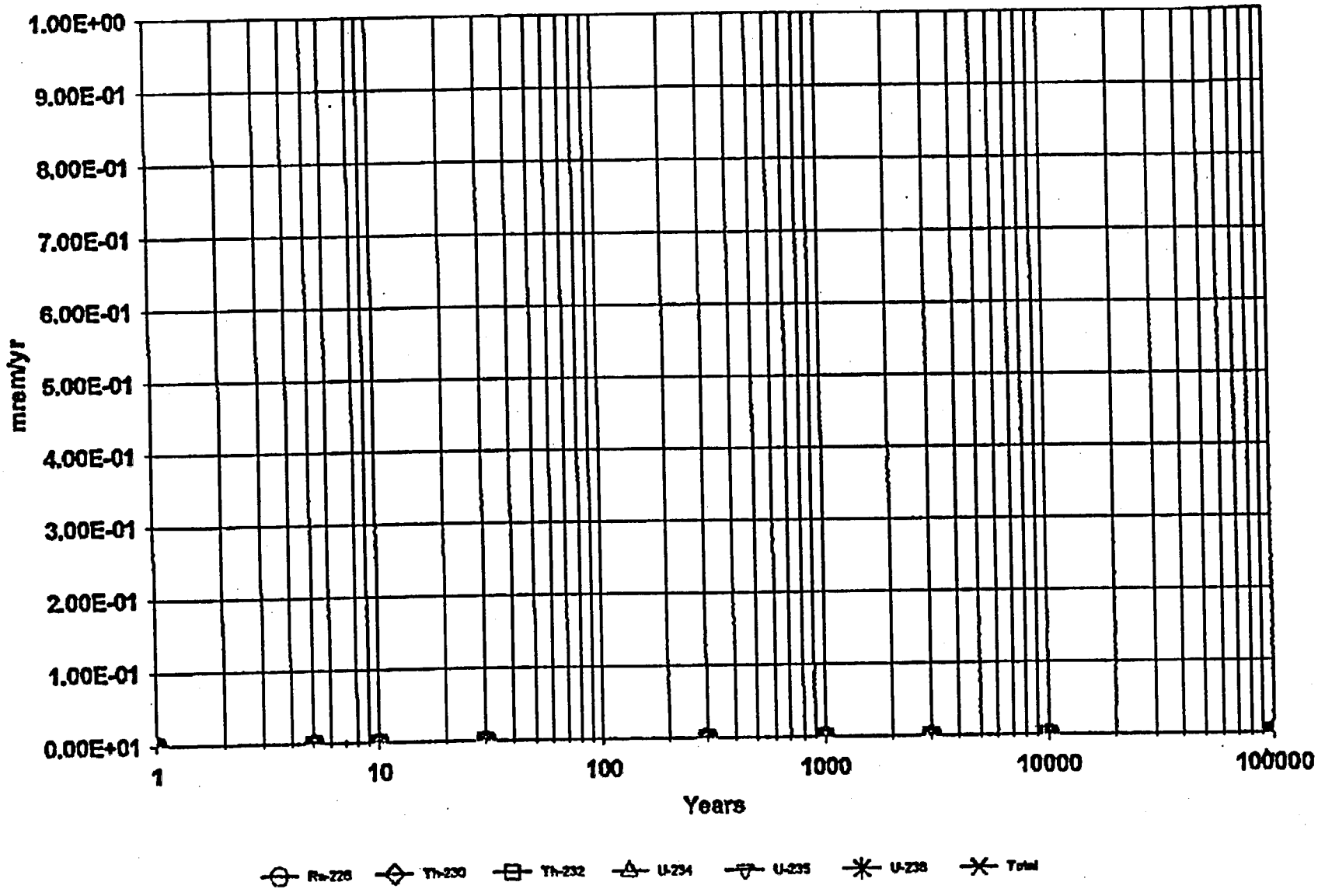
Attachment 1

TSD-DOSE Analysis for Disposal of Unimportant Quantities of Source Material at the WCS Andrews Facility

Attachment 2

RESRAD Analysis for Disposal of Unimportant Quantities of Source Material at the WCS Andrews Facility

DOSE: All Nuclides Summed, All Pathways Summed



RAREARTH.RAD 04/14/2000 10:50 Includes All Pathways

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Dose Conversion Factor (and Related) Parameter Summary
File: Default.LIB

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(3)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(4)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(5)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(6)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(7)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(8)
B-1	U-234	1.320E-01	1.320E-01	DCF2(9)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(10)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(3)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(4)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(5)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(6)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(7)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(8)
D-1	U-234	2.830E-04	2.830E-04	DCF3(9)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(10)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(11)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				

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D-34 ³ Ra-226+D , plant/soil concentration ratio, dimensionless    ³ 4.000E-02 ³ 4.000E-02 ³ RTF( 4,1)
D-34 ³ Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 1.000E-03 ³ 1.000E-03 ³ RTF( 4,2)
D-34 ³ Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 1.000E-03 ³ 1.000E-03 ³ RTF( 4,3)
D-34 ³                                                             ³           ³           ³
D-34 ³ Ra-228+D , plant/soil concentration ratio, dimensionless    ³ 4.000E-02 ³ 4.000E-02 ³ RTF( 5,1)
D-34 ³ Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 1.000E-03 ³ 1.000E-03 ³ RTF( 5,2)
D-34 ³ Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 1.000E-03 ³ 1.000E-03 ³ RTF( 5,3)
D-34 ³                                                             ³           ³           ³
D-34 ³ Th-228+D , plant/soil concentration ratio, dimensionless    ³ 1.000E-03 ³ 1.000E-03 ³ RTF( 6,1)
D-34 ³ Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 1.000E-04 ³ 1.000E-04 ³ RTF( 6,2)
D-34 ³ Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 5.000E-06 ³ 5.000E-06 ³ RTF( 6,3)
D-34 ³                                                             ³           ³           ³
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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: Default.LIB

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				

D-5	Th-230	, fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230	, crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5					
D-5	Th-232	, fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232	, crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5					
D-5	U-234	, fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234	, crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5					
D-5	U-235+D	, fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D	, crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5					

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: Default.LIB

Menu	Parameter	Current Value	Default	Parameter Name
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+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)	3.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+04	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+05	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.665E+02	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-230	1.665E+02	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): Th-232	5.450E+01	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): U-234	1.665E+02	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-235	7.800E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-238	1.665E+02	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	5.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	2.350E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.830E-06	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+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)	1.000E+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	8.000E-01	5.000E-01	---	EVAPTR

R013	Precipitation (m/yr)	3.550E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.000E-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
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	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)	3.000E+02	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	2.350E+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	6.000E-02	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-03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.686E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.972E-07	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.972E-07	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)

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R016 ³   Unsaturated zone 1 (cm**3/g)        ³ 5.000E+01 ³ 5.000E+01 ³          ---          ³ DCNUCU( 9,1)
R016 ³   Saturated zone (cm**3/g)            ³ 5.000E+01 ³ 5.000E+01 ³          ---          ³ DCNUCS( 9)
R016 ³   Leach rate (/yr)                    ³ 0.000E+00 ³ 0.000E+00 ³      2.358E-04        ³ ALEACH( 9)
R016 ³   Solubility constant                 ³ 0.000E+00 ³ 0.000E+00 ³      not used         ³ SOLUBK( 9)
     ³                                       ³           ³           ³                       ³
R016 ³ Distribution coefficients for U-235   ³           ³           ³                       ³
R016 ³   Contaminated zone (cm**3/g)         ³ 5.000E+01 ³ 5.000E+01 ³          ---          ³ DCNUCC(10)
R016 ³   Unsaturated zone 1 (cm**3/g)        ³ 5.000E+01 ³ 5.000E+01 ³          ---          ³ DCNUCU(10,1)
R016 ³   Saturated zone (cm**3/g)            ³ 5.000E+01 ³ 5.000E+01 ³          ---          ³ DCNUCS(10)
R016 ³   Leach rate (/yr)                    ³ 0.000E+00 ³ 0.000E+00 ³      2.358E-04        ³ ALEACH(10)
R016 ³   Solubility constant                 ³ 0.000E+00 ³ 0.000E+00 ³      not used         ³ SOLUBK(10)
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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.358E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.865E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.358E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.181E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.686E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
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	1.972E-07	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

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)
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	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	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

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
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	---	DMC
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
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	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	4.270E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	4.180E-01	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.000E-02	3.000E-02	---	PH2OFL

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	-1.000E+00	2.000E-06	1.943E-09	DIFCV
R021	in foundation material	3.000E-07	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	-1.000E+00	-1.000E+00	code computed (time dependent)	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	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

Contaminated Zone Dimensions	
Area:	10000.00 square meters
Thickness:	2.00 meters
Cover Depth:	5.00 meters

Initial Soil Concentrations, pCi/g	
Ra-226	1.665E+02
Th-230	1.665E+02
Th-232	5.450E+01
U-234	1.665E+02
U-235	7.800E+00
U-238	1.665E+02

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 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	3.000E+03	1.000E+04	1.000E+05
TDOSE(t):	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

0Maximum TDOSE(t): 0.000E+00 mrem/yr at t = 0.000E+00 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
0 Water Independent Pathways (Inhalation excludes radon)
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)

0 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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways

0 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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways
0

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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide														
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide														
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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
0 Water Independent Pathways (Inhalation excludes radon)

0 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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	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
0 Water Dependent Pathways

0 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.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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+03 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0

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+03 years
0 Water Dependent Pathways

0 Radio- Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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	0.000E+00	0.0000

0*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+04 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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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	0.000E+00	0.0000

0

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+04 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
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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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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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	0.000E+00	0.0000

0*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+05 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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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	0.000E+00	0.0000

0

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+05 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
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	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	0.000E+00	0.0000
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	0.000E+00	0.0000
U-234	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
U-235	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
U-238	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
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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	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

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

0Parent (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	3.000E+03	1.000E+04	1.000E+05
Ra-226	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	0.000E+00	0.000E+00	0.000E+00
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	0.000E+00	0.000E+00	0.000E+00
Ra-226	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Th-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	0.000E+00	0.000E+00	0.000E+00
Th-230	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	0.000E+00	0.000E+00	0.000E+00
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	0.000E+00	0.000E+00	0.000E+00
Th-230	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Th-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	0.000E+00	0.000E+00	0.000E+00
Th-232	Ra-228	1.000E+00	0.000E+00	0.000E+00	0.000E+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-228	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.336E-38	4.176E-38	7.476E-37
Th-232	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.336E-38	4.176E-38	7.476E-37
0U-234	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	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	0.000E+00	0.000E+00	0.000E+00
U-234	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	0.000E+00	0.000E+00	0.000E+00
U-234	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	0.000E+00	0.000E+00	0.000E+00
U-234	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-235	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	Pa-231	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	Ac-227	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-238	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	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	0.000E+00	0.000E+00	0.000E+00
U-238	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	0.000E+00	0.000E+00	0.000E+00
U-238	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	0.000E+00	0.000E+00	0.000E+00
U-238	ÄDSR(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ffffffff	ffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff	ffffffffff

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide

(i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	3.000E+01	3.000E+02	1.000E+03	3.000E+03	1.000E+04	1.000E+05
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Ra-226	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11
Th-230	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10	*2.018E+10
Th-232	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05	*1.096E+05
U-234	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05
ffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff	fffffffff

*At specific activity limit

0

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 = 0.000E+00 years

0Nuclide

(i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Ra-226	1.665E+02	0.000E+00	0.000E+00	*9.882E+11	0.000E+00	*9.882E+11
Th-230	1.665E+02	0.000E+00	0.000E+00	*2.018E+10	0.000E+00	*2.018E+10
Th-232	5.450E+01	0.000E+00	0.000E+00	*1.096E+05	0.000E+00	*1.096E+05
U-234	1.665E+02	0.000E+00	0.000E+00	*6.245E+09	0.000E+00	*6.245E+09
U-235	7.800E+00	0.000E+00	0.000E+00	*2.160E+06	0.000E+00	*2.160E+06
U-238	1.665E+02	0.000E+00	0.000E+00	*3.360E+05	0.000E+00	*3.360E+05
ffffffff	fffffffff	ffffffffffffffffff	fffffffff	fffffffff	fffffffff	fffffffff

*At specific activity limit

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

0Nuclide (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	3.000E+03	1.000E+04	1.000E+05
Ra-226	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	0.000E+00	0.000E+00	0.000E+00
Ra-226	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	0.000E+00	0.000E+00	0.000E+00
Ra-226	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	ÄDOSE(j):		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Pb-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	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	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	ÄDOSE(j):		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Th-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	0.000E+00	0.000E+00	0.000E+00
Th-230	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	ÄDOSE(j):		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Th-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	0.000E+00	0.000E+00	0.000E+00
0Ra-228	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	0.000E+00	0.000E+00	0.000E+00
0Th-228	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	0.000E+00	0.000E+00	0.000E+00
0U-234	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	ÄDOSE(j):		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-235	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Pa-231	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Ac-227	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-238	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+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

0Nuclide (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	3.000E+03	1.000E+04	1.000E+05
Ra-226	Ra-226	1.000E+00	1.665E+02	1.664E+02	1.660E+02	1.655E+02	1.635E+02	1.390E+02	9.121E+01	2.737E+01	4.052E-01	1.213E-24
Ra-226	Th-230	1.000E+00	0.000E+00	7.211E-02	3.601E-01	7.191E-01	2.144E+00	1.977E+01	5.392E+01	9.839E+01	1.107E+02	4.851E+01
Ra-226	U-234	1.000E+00	0.000E+00	3.246E-07	8.105E-06	3.237E-05	2.897E-04	2.686E-02	2.464E-01	1.333E+00	3.646E+00	1.903E+00
Ra-226	U-238	1.000E+00	0.000E+00	3.063E-13	3.830E-11	3.060E-10	8.216E-09	7.639E-06	2.349E-04	3.816E-03	3.038E-02	2.380E-02
Ra-226	åS(j):		1.665E+02	1.665E+02	1.664E+02	1.662E+02	1.657E+02	1.588E+02	1.454E+02	1.271E+02	1.148E+02	5.043E+01
0Pb-210	Ra-226	1.000E+00	0.000E+00	5.094E+00	2.392E+01	4.432E+01	9.978E+01	1.412E+02	9.265E+01	2.780E+01	4.116E-01	1.232E-24
Pb-210	Th-230	1.000E+00	0.000E+00	1.109E-03	2.660E-02	1.011E-01	7.510E-01	1.774E+01	5.245E+01	9.766E+01	1.103E+02	4.834E+01
Pb-210	U-234	1.000E+00	0.000E+00	3.337E-09	4.041E-07	3.110E-06	7.252E-05	2.180E-02	2.321E-01	1.310E+00	3.628E+00	1.896E+00
Pb-210	U-238	1.000E+00	0.000E+00	1.721E-15	1.443E-12	2.238E-11	1.608E-09	5.672E-06	2.146E-04	3.711E-03	3.017E-02	2.372E-02
Pb-210	åS(j):		0.000E+00	5.095E+00	2.395E+01	4.442E+01	1.005E+02	1.589E+02	1.453E+02	1.268E+02	1.144E+02	5.026E+01
0Th-230	Th-230	1.000E+00	1.665E+02	1.665E+02	1.665E+02	1.665E+02	1.665E+02	1.660E+02	1.650E+02	1.620E+02	1.519E+02	6.636E+01
Th-230	U-234	1.000E+00	0.000E+00	1.499E-03	7.489E-03	1.497E-02	4.480E-02	4.333E-01	1.327E+00	3.162E+00	5.357E+00	2.603E+00
Th-230	U-238	1.000E+00	0.000E+00	2.124E-09	5.307E-08	2.121E-07	1.903E-06	1.822E-04	1.811E-03	1.195E-02	4.953E-02	3.256E-02
Th-230	åS(j):		1.665E+02	1.665E+02	1.665E+02	1.665E+02	1.665E+02	1.665E+02	1.663E+02	1.651E+02	1.573E+02	6.899E+01
0Th-232	Th-232	1.000E+00	5.450E+01	5.450E+01	5.450E+01	5.450E+01	5.450E+01	5.450E+01	5.449E+01	5.447E+01	5.439E+01	5.344E+01
0Ra-228	Th-232	1.000E+00	0.000E+00	6.189E+00	2.466E+01	3.815E+01	5.297E+01	5.442E+01	5.441E+01	5.439E+01	5.432E+01	5.336E+01
0Th-228	Th-232	1.000E+00	0.000E+00	1.016E+00	1.423E+01	3.074E+01	5.224E+01	5.442E+01	5.441E+01	5.439E+01	5.432E+01	5.336E+01
0U-234	U-234	1.000E+00	1.665E+02	1.665E+02	1.663E+02	1.661E+02	1.653E+02	1.550E+02	1.311E+02	8.137E+01	1.531E+01	7.179E-09
U-234	U-238	1.000E+00	0.000E+00	4.719E-04	2.357E-03	4.709E-03	1.406E-02	1.319E-01	3.723E-01	6.950E-01	4.401E-01	2.353E-09
U-234	åS(j):		1.665E+02	1.665E+02	1.663E+02	1.661E+02	1.653E+02	1.551E+02	1.315E+02	8.206E+01	1.575E+01	9.532E-09
0U-235	U-235	1.000E+00	7.800E+00	7.798E+00	7.791E+00	7.782E+00	7.745E+00	7.267E+00	6.161E+00	3.844E+00	7.377E-01	4.465E-10
0Pa-231	U-235	1.000E+00	0.000E+00	1.650E-04	8.242E-04	1.646E-03	4.915E-03	4.598E-02	1.290E-01	2.364E-01	1.407E-01	3.927E-10
0Ac-227	U-235	1.000E+00	0.000E+00	2.598E-06	6.221E-05	2.361E-04	1.744E-03	4.078E-02	1.237E-01	2.315E-01	1.388E-01	3.884E-10
0U-238	U-238	1.000E+00	1.665E+02	1.665E+02	1.663E+02	1.661E+02	1.653E+02	1.551E+02	1.315E+02	8.206E+01	1.575E+01	9.532E-09

BRF(i) is the branch fraction of the parent nuclide.
0RESMAIN5.EXE execution time = 62.34 seconds