TDH
Texas Department of Health

Eduardo J. Sanchez, M.D., M.P.H.
Commissioner of Health

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Radiation Control
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Gary R. Bego
Chief Operating Officer

Charles E. Bell, M.D.
Executive Deputy Commissioner

August 6, 2002

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STP

Ms. Josephine Piccone
Deputy Director
Office of State and Tribal Programs, Mailstop O3-C10
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

Dear Ms. Piccone:

Enclosed is a petition for rulemaking submitted to the Texas Department of Health by Waste Control Specialists, L.L.C. (WCS). WCS proposes the amendment of existing Texas Administrative Code (TAC) 25 TAC §289.202 (fff) concerning exemption of specific wastes. The amendment proposed in the petition would allow licensees to dispose of low activity licensed radioactive material at a RCRA Subtitle C disposal facility if it can be shown that the risk from transportation and disposal does not exceed a TEDE to an average member of the critical group of 1 mrem (0.01 mSv) per year, including that from groundwater sources of drinking water.

The Texas Department of Health, Bureau of Radiation Control is requesting input from the U.S. Nuclear Regulatory Commission as to potential impacts of this petition for rulemaking, particularly the impact on the national program (i.e., ongoing efforts on the clearance of solids) and possible issues with compatibility.

In accordance with Texas statutes, the Board of Health must consider this petition within 60 days of receipt. The Board of Health must deny or accept the petition in whole or in part and if accepted, will refer the petition to the appropriate program to initiate the rulemaking process. In this case, the Bureau of Radiation Control is the appropriate program. To meet the 60-day statutory requirement, the Board of Health will consider the petition during its September 5-6, 2002 meeting.

STP-006 Template
RIDS DIST. SP08

We appreciate your consideration of this issue and ask that we receive a response as soon as possible. If you have questions or need additional information, please contact Cindy Cardwell at 512-834-6688, ext. 2239 or Cindy.Cardwell@tdh.state.tx.us.

Sincerely,

Ruth E. McBurney

Ruth E. McBurney, CHP, Acting Chief
Bureau of Radiation Control

ENCLOSURES

WCS WASTE CONTROL SPECIALISTS LLC

P.O Box 1129, Andrews, TX 79714 (888)789-2783 • Fax (505)394-3427

July 26, 2002

Commissioner Charles E. Bell, M.D.
Texas Department of Health
100 West 49th St
Austin, TX 78756-3189

Re: Petition for Adoption of Rules

Dear Commissioner Bell,

Please find enclosed a Petition for Adoption of Rules filed on behalf of Waste Control Specialists, L.L.C This filing is in accordance with Texas Department of Health Rule 25 TAC §1.81 (Petition for the Adoption of a Rule). Please direct all correspondence regarding this matter to my attention.

Please do not hesitate to contact me should you have any questions or comments.

Sincerely,

William P Dornsife

William P. Dornsife
Vice President – Nuclear Affairs

Enclosures

cc: Richard A. Ratliff, P,E., Chief, Bureau of Radiation Control Texas Department of Health w/enclosures

PETITION FOR ADOPTION OF RULES

COMES NOW Waste Control Specialist, LLC, ("WCS") and respectfully petitions the Texas Department of Health ('TDH') in accordance with TEX. GOV'T CODE §2001.021 and 25 T.A.C. §1.81 [Petition for Adoption of Rules], and would show the following:

I
Statutory Authority

Statutory authority for the promulgation of this rule is found at TEXAS HEALTH AND SAFETY CODE §401.051 which provides for the TDH to adopt rules and guidelines relating to the control of sources of radiation, and TEXAS HEALTH AND SAFETY CODE §401.106 which allows the TDH by rule to exempt a source of radiation or a kind of use or user from licensing or registration requirements.

II
Explanation of Rule and Public Benefit

WCS proposes the amendment of existing Texas Administrative Code (TAC) 25 TAC §289.202(fff) (General requirements for waste management) by adding a section that would allow licensees to dispose of low activity licensed radioactive material at a RCRA Subtitle C disposal facility if it can be shown that the risk from transportation and disposal does not exceed a TEDE to an average member of the critical group of 1 mrem (0.01 mSv) per year, including that from groundwater sources of drinking water.

WCS believes this rule will help fulfill an important state need, the need to provide a safe and cost effective disposal option for a very limited category of low activity radioactive waste that is currently either being stored at licensed facilities or disposed out of state at great expense to licensees in Texas. The essential concept that underlies the proposed rule is that hazards from certain kinds of low activity radioactive waste are such that the characteristics of a RCRA-permitted hazardous waste disposal facility and the underlying structure of the RCRA-regulatory program provide adequate protection without the need to deal with the waste as "radioactive" and subject to full disposal licensing provisions.

The TDH has adopted similar exemptions for specific waste streams in 25 TAC §289.202(fff). This proposed rule would be an extension of and used in conjunction with 25 TAC §289.202(fff)(4-9), which allows discarding of short-lived radioactive material in a sanitary landfill and a RCRA disposal cell. The methodology and dose criteria for this proposed rulemaking is similar to that used for the existing rule and its supporting analysis[1].

The USNRC, in its Final Staff Technical Position regarding the Disposition of Cesium-137 Contaminated Emission Control Dust and Other Incident-Related Material ("NRC Technical Position",

[1] "Disposal of Short-lived Radionuclide Wastes in a Sanitary Landfill: Final Report", for Texas Low-Level Radioactive Waste Disposal Authority, Rogers and Associates Engineering Corporation, February 1987.

62 Fed. Reg. 13, 176 (March 19, 1997), has endorsed this concept for K061 waste contaminated with limited amounts of Cs-137 and has given the states the option to choose to regulate the disposal of this limited category of waste as if it were, in the particular sense described, not radioactive.

The USEPA is also in the process of endorsing this concept and has developed a draft rulemaking that would allow low activity radioactive waste to be disposed at a RCRA Subtitle C disposal facility. A preliminary risk assessment has been performed for this draft rulemaking that is based on not exceeding a dose of 10 mrem per year. The USEPA is expected to issue an advanced notice of proposed rulemaking in the near future to formally begin the rulemaking process. The limits developed under this proposed rule are consistent with those developed by the USEPA in the draft rulemaking.

Disposal of low activity radioactive waste at RCRA Subtitle C disposal facilities can be performed safely and provides an equivalent level of protection to public health and safety as disposal at licensed LLRW disposal facilities. RCRA disposal facility requirements meet or exceed 10 CFR Part 61 requirements in the following areas related to design and institutional control:

- RCRA requires a minimum of 30 years active maintenance verses 5 years for Part 61.
- RCRA requires deed restrictions that prevent disturbing the cover after the facility has been closed, Part 61 has no such requirement.
- Many RCRA disposal facilities include a five meter engineered cover that would satisfy the Part 61 intruder barrier requirement for Class C waste.
- RCRA facilities must meet prescriptive design requirements that include double liners, minimum permeability standards, and leachate collection and monitoring systems. Part 61 has no facility design requirements.
- There is no requirement under RCRA for long-term government ownership of the facility after closure, but this requirement has been waived by the NRC for the Envirocare facility.
- Existing RCRA disposal facility site permits and other licenses require various financial assurance instruments that provide for equivalent levels of funding 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 the licensee cannot perform this activity
- Various studies have shown that the long-lived toxicity of RCRA waste is comparable to low activity LLRW.[2]

Various national and international radiation standard setting bodies have recommended that 1 mrem/yr be accepted as a negligible individual dose. This dose translates to an annual risk of death of about 5E-07, which is considered by various experts to constitute a trivial or negligible risk. Regulatory agencies do not normally regulate risks that are less than an annual risk of death of 1E-06. This standard is also used as the basis for ANSI/HPS N13.12-1999, and a more detailed discussion of its appropriateness can be found in that standard[3]. The risk based methodology proposed for use in this rulemaking is similar to the methodology in the short-lived disposal rule 25 TAC §289.202(fff), the decommissioning rule (25 TAC 289.202(ddd) and the TNRCC rules for alternate disposal (30 TAC 336.513(c)).

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[2] "A Perspective on the Relative Hazard of Low-Level Radioactive Waste Disposal", Low-Level Radioactive Waste Management - Proceedings of Health Physics Society Twelfth Midyear Topical Symposium, February, 1979, W. P. Domsife.

[3] ANSI/HPS N13.12-1999, "Surface and Volume Radioactivity Standards for Clearance"

Each licensee that intends to use the provisions of this proposed rule would have to verify that their low activity waste meets the concentration limits for the short/long distance transportation scenario and humid/dry RCRA sites, and also verify that the annual activity limits per licensee is not exceeded. If the RCRA facility has a radioactive material license and all workers are badged as radiation workers, the annual curie limit would not be applicable, since the facilities radiation control program will adequately control any radiation exposure to the workers. Under these proposed rules a dry RCRA site is defined as meeting all the following requirements: (1) average rainfall less than 15 inches per year; (2) regional aquifer is at least 300 feet below the disposal cell; and (3) permeability of the vadose zone is less than 1.0E-07 cm/sec. This procedure is similar and complementary to that already required for short–lived radionuclides exempted under 25 TAC §289.202(fff)(4-9).

Radioactive waste toxicity studies[4] have shown that the risk from disposal of this material is similar to material that is exempted from licensing in 25 TAC §251, and is currently being disposed at RCRA disposal facilities in Texas. Similar risk assessments currently need to be performed for disposal of exempt waste from NRC licensed and DOE sites.

This proposal will primarily benefit hospitals, universities, and industries in Texas resulting in a significant saving of public dollars and the elimination of the risks and security concerns from indefinite on-site storage. The availability of cost effective disposal in Texas will also facilitate the cleanup and decommissioning of sites where cleanup is currently problematic and a source of significant health and safety risk. Since the State of Texas does not license nuclear power plants, they cannot implement the provisions of this proposed rule. Adoption of proposed changes to 25 TAC §289.202(fff) will provide benefits to the public of a health-protective, environmentally sound, and cost-effective alternative for the disposal of this low activity radioactive waste.

III

Proposed Amendments to 25 TAC §289.202

The amendment is proposed under the Health and Safety Code, Chapter 401, which provides the Texas Board of Health with authority to adopt rules and guidelines relating to the control of radiation; and §12.001, which authorizes the board to adopt rules for the performance of every duty imposed by law on the board, the department, and the commissioner of health.

This amendment affects Health and Safety Code, Chapter 401.

Add a new section to 25 TAC §289.202(fff) as follows:

(5) Any licensee may, upon agency approval of procedures required in paragraph (7) of this subsection, discard licensed material included in subsection (ggg)(9) of this section, provided that it does not exceed the concentration and total curie limits contained therein, in a permitted hazardous

[4] "A Methodology For Evaluating the Toxicity of Radioactive Waste and Its Application to the Radioactive Waste Generated in Pennsylvania", Health Physics, 69(2): 162-177 (August ,1995). W.P. Dornsife.

waste disposal facility (defined in the Industrial Solid and Municipal Hazardous Waste Regulations of the authorized regulatory agency - 30 Texas Administrative Code Chapter 335).

Add a new section to 25 TAC §289.202(ggg) as follows:

(ggg)(9) Concentration and activity limits of nuclides for disposal in a hazardous waste facility (for use in subsection (fff) of this section). The following table contains concentration and activity limits of nuclides for disposal in a hazardous waste facility.

Radionuclide	Allowable Concentration based on <50 mile driving distance (pCi/gm)	Allowable Concentration based on >50 mile driving distance (pCi/gm)	Total Activity per licensee per year (Ci/yr) (a)	Allowable Concentration at humid RCRA site (pCi/gm)	Allowable Concentration at dry RCRA site (pCi/gm) (b)
Ac-227+D	1667	154	0.27		
Ag-108+D	357	32	0.11		
Al-26	204	17	0.065		
Am-241			7.6	27	27
Am243+D			1.1	27	27
Au-195	31250	4440	8 2		
Ba-133				2700	2700
Bi-207	370	33	0.12		
C-14				0.51	270000
Ca-41				2700000	2700000
Cd-109	416700	45450	118.3		
Cf-252				27	27
Cl-36				0.08	0.2
Cm-242				27	27
Cm-243			1.5	27	27
Cm-244				27	27
Cm-245				27	27
Cm-246				27	27
Cm-247				27	27
Cm-248			2.3	27	27
Co-60	217	20	0 071		
Cs-134	364	32	0.12		
Cs-135				270000	270000
Cs-137+D	1000	91	0 32		
Eu-152	500	44	0.16		
Eu-154	465	42	0.14		
Eu-155	28170	3450	7.6		
Fe-55				270000	270000
Gd-153	41670	7690	9.7		
Ge-68+D	606	54	0 19		
H-3				19.5	2000000
I-129				0 021	2700
Ir-192	740	65	0 23		
K-40	3450	308	1.1		
Mn-54	667	61	0.22		
Na-22	253	22	0 079		
Nb93m				270000	270000
Nb-94	357	32	0.11		
Ni-59				270000	270000
Ni-63				2700000	2700000
Np-237+D			0.85	27	27

Radionuclide	Allowable Concentration based on <50 mile driving distance (pCi/gm)	Allowable Concentration based on >50 mile driving distance (pCi/gm)	Total Activity per licensee per year (Ci/yr) (a)	Allowable Concentration at humid RCRA site (pCi/gm)	Allowable Concentration at dry RCRA site (pCi/gm) (b)
Pa-231	18180	1540	1.9		
Pb-210+D				270	270
Pm-147				270000	270000
Po-210(U8)				270	270
Pu-238			9.7	27	27
Pu-239			8.9	27	27
Pu-240			8.9	27	27
Pu-241+D				27	27
Pu-242			9.3	27	27
Pu-244+D			0.14	27	27
Ra-226+D		28	0.1	80	124
Ru-106+D	2670	235	0 85		
Sb-125+D	1430	125	0.43		
Se-79				270000	270000
Sm-147				270	270
Sm-151				270000	270000
Sr-90+D				2700	2700
Ta-182	444	40	0.14		
Tc-99				0.88	270000
Te-125m				27000	27000
Th229+D	2200	200	0.48		
Th-230			11.8	229	230
Th-232+all D*	220	18	0.069		
Tl-204				270000	270000
U-232			5.8	27	27
U-233				270	270
U-234				270	270
U-235+D			1.3	270	270
U-236				270	270
U-238+D			6 6	270	270
Zr-93				27000	27000

* Includes Ra-228+D and Th-228+D

(a) The total activity limit per generator does not apply if the RCRA facility receiving the waste has a radioactive material or waste license and all workers are badged as radiation workers.

(b) A dry RCRA site is defined as meeting all the following requirements: (1) average rainfall less than 15 inches per year; (2) regional aquifer is at least 300 feet below the disposal cell; and (3) permeability of the vadose zone is less than 1.0E-07 cm/sec.

For other radionuclides not included in this Table, the maximum allowable concentrations will be the effluent concentrations in Table II, Column 2 of 25 TAC 289.202(ggg)(2)(F) of this section, with the units changed from microcuries per milliliter to microcuries per gram.

In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this paragraph shall be determined as follows: For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in this paragraph for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

WHEREFORE PREMISES CONSIDERED WCS respectfully requests that the TDH institute rulemaking in accordance with its rules, and thereby formally adopt proposed changes to 25 TAC §289.202(fff). Filed with the Commissioner of Health on July 26, 2002

Respectfully submitted,

William P Dornsife

William P. Dornsife
Vice President-Nuclear Affairs
Waste Control Specialists

Disposal of Low Activity Radioactive Waste in a RCRA Subtitle C Landfill

The purpose of this report is to determine allowable concentrations of various radionuclides that could be transported and disposed at a RCRA Subtitle C disposal facility in Texas without exceeding a dose of 1 mrem/yr to any member of the public not considered to be a radiation worker. This work is in support of a proposed rulemaking request that is similar to a proposed rulemaking request for short-lived radionuclides and its supporting work[1] that was approved by the TDH and adopted as 25 TAC 289.202(fff)(4)-(9). Implementation of these proposed regulations for disposal of low activity radioactive waste at a RCRA disposal facility would benefit hospitals, universities, and industries in Texas and result in a significant saving of public dollars and the elimination of the risks from indefinite on-site storage. An additional benefit will be the availability of cost effective disposal for the cleanup and decommissioning of sites where cleanup is currently problematic and a source of significant health and safety risk. Since the State of Texas does not license nuclear power plants and certain other large generators of radioactive waste, they cannot implement the provisions of this proposed rule.

Methodology

Dose To Non-Radiation Workers During Transport, Receipt, Processing, And Disposal

In order to assess the impact to non-radiation workers from the transport, receipt, processing, and disposal of low activity radioactive waste, an analysis was performed using the TSD-DOSE model (V 2.22)[2]. 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 that may contain small amounts of radioisotopes.

The steps and parameters used to model the operations were chosen to be conservative yet realistic. In other words, engineering judgment and knowledge from several site visits was used to develop a model which could be applied to most TSD facilities and would produce conservative dose estimates in almost all cases (almost all because not every TSD facility was visited such that the conservatism of the model may not cover a site that has characteristics outside of the model). The default values were chosen to bound the TSD facilities visited.

TSD-DOSE estimates worker and public doses from seven operations. These operations can be turned on or off to reflect the actual TSD facility operations. In addition, many of the parameters used to model the typical operations can be adjusted to fit the actual facility. A dose is calculated for each operation based on radionuclide activities, waste characteristics, and any 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.

Ver 2.2 of the TSD-DOSE model was used to calculate the dose to the truck driver, the non-radiation worker at the TSD facility, and the public during transport and handling of the low activity material.

The worst-case scenario that will maximize the dose to the driver and the non-radiation worker at the TSD facility is a load of drums on a trailer that requires RCRA treatment prior to disposal. The total volume of waste per shipment is assumed to be 376 ft^3 or about 50 drums. In order to calculate the

maximum dose to the non-radiation worker at the TSD facility for this worst-case scenario, the following assumptions for the seven operations in the TSD-DOSE model will be made.

Transport to the TSD facility.

The steps in this operation are: Load and secure shipment prior to transport; Drive loaded truck to TSD facility; Rest in back of cab en route to TSD facility; Maintenance (i.e. checking tires or refueling) of truck en route to TSD facility.

Since total dose to the truck driver is the critical factor for most of the radionuclides, two transportation distances from the generator to the TSD facility were assumed for the TSD-DOSE analysis; a short distance (<50 miles) and a long distance (600 miles). For both scenarios it is assumed that the driver spends 1 hour at a distance of three feet while the waste is being loaded. For the short driving distance scenario (50 miles), it is assumed that the driver is exposed for one hour at a distance of 7 feet from the waste with no rest and no maintenance. For the long driving distance scenario (600 miles), it is assumed that the driver is exposed for twelve hours at a distance of 7 feet from the waste, eight hours at distance of two feet while resting, and one hour at a distance of 3 feet during maintenance.

Receiving and sampling.

Weigh and survey truck and inspect manifest:

Two non-radiation workers for fifteen minutes at the default distance of 5 feet.

Unload drums for inspection, sampling and storage prior to treatment:

Two non-radiation workers for default values; five minutes per drum at a distance of 3 feet.

Inspect and sample drums.

Two non-radiation workers for 10% of the default value of five minutes per drum(RCRA sampling frequency) at the default distance of 0.5 feet. Default inhalation dose from open drum is also assumed.

Transfer drums to storage awaiting treatment.

Two non-radiation workers for default values; ten minutes per drum at a distance of 3 feet.

Pump drummed liquids to storage.

Not applicable.

Storage.

Work in solid storage area.

Five hours at a distance of 5 feet during assumed one week storage time.

Transfer drums out of storage are for treatment.

Default value of ten minutes per drums at a distance of three feet.

Work in liquid storage area.

Not applicable.

Incineration.

This operation was not included.

Treatment and on-site landfill.

Unload waste to mixing pit.

One non-radiation worker at the default values of fifteen minutes at a distance of 5 feet. Default inhalation dose from open drum is also assumed.

Mix waste in mixing pit.
One non-radiation worker at the default values of thirty minutes at a distance of 10 feet.
Load truck and transport to landfill.
One non-radiation worker at the default values of fifteen minutes at a distance of 5 feet.
Unload truck at landfill.
One non-radiation worker at the default values of fifteen minutes at a distance of 5 feet.

Transport to off-site landfill.
This operation was not included.

Incinerator maintenance.
This operation was not included.

This scenario will be used to calculate the critical dose to non-radiation workers from transport and each of the assumed operations at the TSD facility. If it is assumed that an individual driver will not make more than ten shipments per year from any licensee utilizing this proposed rule, the dose to the truck driver is the limiting factor in establishing maximum allowable concentrations for most radionuclides that produce significant external radiation exposure to demonstrate that a dose of 1 mrem/yr will not be exceeded for any non-radiation worker or the member of the public.

Table 1 is a summary of the results for the TSD-DOSE calculations for all 85 radionuclides and their daughter products that are included in the TSD-DOSE model. A sample TSD-DOSE report is included as Attachment A.

Table 1 sample calculations are as follows:
Assumptions for calculating total activity per shipment:
Volume of drums = 18.4ft x 7.3ft x 2.8 ft = 376 ft^3 x 62.4lb/ft3 = 23462lb / 2.2lb/kg = 10665kg = 10.665E+06g x 20pCi/gm = 2.13E+08 Ci = 2.13E-04 Ci per shipment.
Allowable concentrations to not exceed 1 mrem/yr to the truck driver based on 10 trips per year:
1 mrem/yr / (Column 4 – driver mrem/shipment) / 10 shipments per year x 20 pCi/gm = (Column.10 – Allowable concentration pCi/gm)

Since treatment, drum handling and storage account for the most significant portion of the TSD worker exposure, bulk (rolloff on a truck or rail shipments) or drum shipments that do not require treatment prior to disposal result in a dose to the TSD worker that is about an order of magnitude lower. For bulk shipments the dose to the driver is significantly lower and insignificant to the railroad worker.

Another consideration is insuring that the total exposure to any non-radiation worker at the TSD facility is insignificant. A total activity limit per generator has been established at non-licensed TSD facilities to insure that a limit of 1 person-rem/yr total integrated dose to all non-radiation workers will not be exceeded. If the TSD facility has a radioactive material license and all workers are badged as radiation workers, no curie limit is necessary since the facilities radiation control program will adequately control any radiation exposure to the workers. The 1 person-rem/yr limit was selected because it encompasses all exposed workers at a TSD facility and also multiple TSD facilities. Assuming that no more than 10% of the total waste disposed under this proposed rule comes from any one licensee, the total activity is divided by a factor of ten to add additional conservatism. The last column of Table 1 is calculated as follows:

1 person-rem/yr / (Column 7 – Worker population person-rem/shipment) / (10) x (2.13E-04 Ci/shipment) = (Column 11 – Total activity Ci/yr).

An alternate method of showing that the 1 person-rem/yr limit will insure that the dose to the non-radiation worker at the TSD facility will be insignificant is to calculate the curie limit using the worker dose from the worst-case scenario. For most of the radionuclides with significant external exposure the average worker dose is about a factor of ten greater in magnitude than the worker population exposure. For a realistic mix of RCRA/non-RCRA and drums/bulk the average dose to the TSD facility worker will be about an order of magnitude less than the worst case RCRA drum worst-case scenario. It is also likely that at least 10 different TSD facility workers could be exposed to any one shipment. This alternate method gives reasonable assurance that no single TSD facility non-radiation worker will be exposed to a dose of greater than 1 mrem/yr using the same total activity limits that were calculated based on the 1 person-rem/yr total worker exposure method.

Dose to Maximum Exposed Individual After Closure of the RCRA Subtitle C Landfill

An analysis using the RESRAD computer code (V 6.2)[3] has been performed to determine the maximum exposure to an individual member of the public that has unrestricted use of the site after closure of a RCRA cell that has been used for disposal of low activity radioactive waste under this proposed rulemaking. RESRAD is a computer model developed by the Argonne National Laboratory and is designed to estimate radiation doses and risks from RESidual RADioactive materials. RESRAD 6 represents the sixth major version of the RESRAD code since it was first issued in 1989. Since this time, RESRAD has been used widely by the U.S. Department of Energy (DOE), its operations and area offices, and its contractors for deriving limits for radionuclides in soil. RESRAD has also been used by the U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers, U.S. Nuclear Regulatory Commission (NRC), industrial firms, universities, and foreign government agencies and institutions for determining allowable concentrations in soils after site decommissioning and demonstrating that on-site disposal meets appropriate regulatory limits.

After closure of the landfill, it is possible that members of the public 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 would be the possible uses most likely to maximize radiation exposure. Use of groundwater containing landfill constituents for domestic and agricultural purposes or for irrigation is also possible. The landfill siting and construction requirements are designed to minimize the potential for migration of landfill constituents to groundwater, and the required institutional controls after closure make this scenario unlikely. Nevertheless, such a worst-case scenario 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 engineered 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. In the resident farmer scenario, a family is assumed to move onto the site after it has been released for use without radiological restrictions, build a home, and raise crops and livestock for family consumption. Members of the family can incur a radiation dose by the following pathways:

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

These are the pathways that are included in the RESRAD model. Since this model includes almost all of the potential exposure pathways, it is likely to yield the most conservative results. For that reason, the RESRAD model has been selected as the appropriate tool for determining the maximum potential impact from future use of the site after closure. Use of more realistic exposure scenarios would exclude some these potential pathways and would result in lower calculated doses.

The RESRAD model has be used to determine the concentrations at which low activity radioactive waste can be disposed at a RCRA Subtitle C disposal facility without exceeding a 1 mrem/yr effective dose to the maximum exposed individual after disposal site closure.

RESRAD Input Data

Since the hydogeological and climatological conditions are significantly different at an eastern Texas humid RCRA facility verses a western Texas dry site, it will be necessary to calculate limiting concentrations for both types of sites.

The following RESRAD input data are used in the analysis of both RCRA disposal facilities:

- The volume of the contaminated zone is assumed to be 20,000 m^3. Since the waste will be periodically deposited in the RCRA cell with greater volumes of hazardous and industrial waste, the actual concentration could be diluted by as much as an order of magnitude. No credit is taken for this dilution.
- The runoff coefficient is assumed to be 0.4 based on Reference 3, Table E.1.
- The various assumptions for the input parameters that affect ingestion of radionuclides have been changed to the values that are recommended in USNRC guidance, "Preliminary Guidelines for Evaluating Dose Assessments in Support of Decommissioning".
- 1.8 meter thick compacted clay liner with a hydraulic conductivity of 0.03 m/y. This is the design requirement for a RCRA landfill liner.
- Effective porosity and b factor in unsaturated layer input data taken from Reference 3,Table E.8, for clay.
- Kd for each radionulide adapted from Reference 3, Table E.1. Kd of sand was assumed for contaminated and saturated zone. For those radionuclides not in Table E.1, the RESRAD internal calculation method using plant to soil concentrations will be used.

West Texas Dry Site Input Data

The minimum values for the definition of a dry site are used for developing input data for the RESRAD analysis for a dry west Texas site. Actual data from the existing RCRA disposal facility located in Andrews County is shown to demonstrate the conservatism of the calculations.

- 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 x 10^{-6} m/yr.
- The cover is assumed to be 3 m thick compacted clay with no credit taken for any engineered layers or barriers, which is typical for RCRA landfills. The actual design cover thickness at the Andrews County facility is 4.6 meters of compacted clay.
- The hydraulic conductivity of the unsaturated zone is assumed to be about 1 x 10^{-7} cm/sec (≈3 x 10^{-2} m/yr) with a thickness of 91.5 m (300 ft) This is the minimum requirements for a dry site. This is very conservative since the bottom of the disposal cell at the Andrews County site 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 hydraulic conductivity of the Dockum has been measured to be between 10^{-9} and 10^{-8} cm/sec, which gives a average value of about 3 x 10^{-9} cm/sec (≈1 x 10^{-3} m/yr) for the unsaturated zone. The unsaturated zone thickness is actually about 300 m (981 ft) since the Dockum is reported to be between 800 to 1100 ft thick.
- Annual rainfall is asummed to be 0.381. The actual western Andrews County rainfall is 0.355m.
- The irrigation rate is assumed to be 0.2. This is very conservative since irrigation has never been practiced in this region due to depth and non-potability of the aquifer.
- The aquatic pathway is turned off due to the fact that there are typically no surface water bodies near dry sites. For the Andrews County site there is no surface water within at least 50 miles of the site.
- An evapotranspiration coefficient of 0.95 was used to maximize the infiltration rate. This represents an assumed 5 % failure of the cover. Using the actual calculated infiltration rate from a HELP model analysis for the west Texas disposal facility, the actual evapotranspiration coefficient can be calculated using Equation E.4 in Reference 3 as follows: $I=(1-C_e)[(1-C_r)P_r+I_{rr}]$. I=2.74E- 04 m/yr, C_r=0.4, P_r=0.355 m/yr and I_{rr}=0, so C_e=0.9987.
- Other values used for the RESRAD calculations are default values.

East Texas Humid Site Input Data

Since an existing RCRA disposal facility is located in Nueces County, representative data from this area was used for developing input data for the RESRAD analysis for a humid east Texas site as follows:

- The cover erosion rate was calculated using the USDA's universal soil loss equation: $A = R*K*L_s*C*P$. For an established final cover; R=350 (for eastern Texas), 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 =0.378 tons/acre/yr ≈0.04 yd^3/acre/yr = 7.1 x 10^{-6} m/yr.

- The cover is assumed to be 3 m thick compacted clay with no credit taken for any engineered layers or barriers, which is typical for RCRA landfills.
- The hydraulic conductivity of the unsaturated zone is assumed to be about 3 x 10^{-8} cm/sec ($\approx$1 x 10^{-2} m/yr) with a thickness of 4 m (981 ft). This is typical hydrogeology for Nueces County.
- Annual rainfall (0.86m)
- Irrigation rate is asummed to be 0.2 m/yr.
- An evapotranspiration coefficient of 0.95 was used to maximize the infiltration rate. This represents an assumed 5 % failure of the cover. Using the actual calculated infiltration rate from a HELP model analysis for the east Texas disposal facility, the actual evapotranspiration coefficient can be calculated using Equation E.4 in Reference 3 as follows: $I=(1-C_e)[(1-C_r)P_r+I_{rr}]$. I=1.66E-02 m/yr, C_r=0.4, P_r=0.86 m/yr and I_{rr}=0, so C_e=0.9768.
- Other values used for the RESRAD calculations are default values.

The results of the RESRAD analysis for both the humid and dry Texas site are shown in Table 2 for all radionuclides that are included in the RESRAD model. The concentration limits in Table 2 are the maximum allowable limits such that 1 mrem/yr to the maximum exposed individual will not be exceeded in any year for 1000 years after site closure. A sample RESRAD output report for the humid site (H-3 summary report and Ra-226 radon concentration) is included as Attachment B, and for the dry site (Cl-36 summary report and Ra-226 radon concentration) as Attachment C.

Ra-226 and other radionuclides that include Ra-226 in their decay chain may be limited by indoor radon concentrations. The limiting concentrations for these radionuclides are established such that the EPA indoor radon remedial action level of 4 pCi/l will not be exceeded for the 1000 years after site closure.

Final Results of the Analysis

The integrated results of the TSD-DOSE and RESRAD analysis are shown in Table 3. Table 3 shows the maximum allowable concentrations and total curie limits per generator that are required to not exceed a dose of 1 mrem/yr to any non-radiation worker or the maximum exposed individual residing on the disposal site after site closure. Most of the radionuclide concentrations are limited by TSD-DOSE analysis and also have a corresponding curie limit for non-radiation workers. Note that if the TSD facility has a radioactive material license and all workers are badged as radiation workers, the annual curie limit is not applicable since the facilities radiation control program will adequately control any radiation exposure to the workers.

The maximum allowable concentrations for those radionuclides that are not limited by the TSD-DOSE analysis or have no upper bound from the RESRAD analysis will be established by using the larger value of either the IAEA exempt concentrations or the unrestricted soil limits in 25 TAC 289.202(ggg)(8). The IAEA exempt concentration limits are currently used in the international arena for defining radioactive material for transportation purposes and have been proposed by the USNRC for use in this country and should be adopted by early to mid 2003. The soil limits in TDH regulations have been established as unrestricted release limits for purposes decommissioning sites in Texas and under the MOU between TDH and TNRCC can be disposed without regard to their radioactive content.

Table 4 shows the most restrictive concentration and activity limits derived from the above analysis and proposed for use in this rulemaking. Those radionuclides that are already exempted under the short half life disposal regulations are not included in Table 4. For other radionuclides not included in Table 4, the maximum allowable concentrations will be the effluent concentrations in Table II, Column 2 of 25 TAC 289.202(ggg)(2)(F) of this section, with the units changed from microcuries per milliliter to microcuries per gram. This is the same methodology as used in 25 TAC 289.202(eee)(2)(B) to release soil for unrestricted use and exemption from regulated disposal. Also sum of the fractions less than one calculations apply to all concentrations and total annual activity per generator values.

References:

1. "Disposal of Short-lived Radionuclide Wastes in a Sanitary Landfill: Final Report", for Texas Low-Level Radioactive Waste Disposal Authority, Rogers and Associates Engineering Corporation, February 1987.
2. "TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities", Argonne National Laboratory, ANL/EAD/LD-4 (Rev. 1), September 1998.
3. "Users Manual for RESRAD Version 6", Argonne National Laboratory, ANL-EAD-4, July 2001

Attachment A

TSD-DOSE Analysis Reports for Short and Long Transportation Distances

Attachment B

RESRAD Analysis Reports for a Humid RCRA Site

Attachment C

RESRAD Analysis Reports for a Dry RCRA Site

Table 1. Results of TSD-DOSE Analysis for Short and Long Distance transportation to RCRA site.

Radionuclide	Assumed concentration (pCi/gm)	Driving distance (miles)	Driver (mrem/ shipment)	RCRA drums Receiving worker (mrem/ shipment)	RCRA drums Landfill worker (mrem/ shipment)	RCRA drums Worker population (person-rem)	Offsite individual (mrem/ shipment)	Offsite population (person-rem)	Allowable Concentration Driver-based on 10 shipments/yr (pCi/gm)	Total Activity (Receiving worker <1person-rem/yr) (Ci/yr) (a)	Allowable concentration based on RCRA worker (pCi/gm)
Ac-227+D	20	50	1 20E-03	9.80E-03	3.40E-03	7 80E-05	2.10E-05	1.10E-07	1.67E+03	2.73E-01	
Ac-227+D	20	600	1.30E-02	9.80E-03	3.40E-03	7 80E-05	2.10E-05	1.10E-07	1.54E+02	2.73E-01	
Ag-108+D	20	50	5 60E-03	3.50E-02	4 80E-03	1.90E-04	1.50E-07	7.50E-10	3.57E+02	1.12E-01	
Ag-108+D	20	600	6 20E-02	3 50E-02	4.80E-03	1.90E-04	1.50E-07	7.50E-10	3 23E+01	1.12E-01	
Ag-110m+D	20	50	9.90E-03	6.10E-02	8 60E-03	3.30E-04	6.90E-09	3 50E-11	2.02E+02	6.45E-02	
Ag-110m+D	20	600	1 10E-01	6.10E-02	8 60E-03	3.30E-04	6.90E-09	3.50E-11	1.82E+01	6.45E-02	
Al-26	20	50	9 80E-03	5 90E-02	8.60E-03	3.30E-04	2.80E-07	1.40E-09	2.04E+02	6.45E-02	
Al-26	20	600	1.20E-01	5 90E-02	8.60E-03	3.30E-04	2.80E-07	1.40E-09	1.67E+01	6.45E-02	
Am-241	20	50	7 40E-06	2.20E-04	2.20E-03	2 80E-06	1.30E-06	6.30E-09	2.70E+05	7.61E+00	9.09E+03
Am-241	20	600	3.70E-05	2.20E-04	2 20E-03	2.80E-06	1.30E-06	6.30E-09	5.41E+04	7.61E+00	
Am243+D	20	50	5 00E-04	3.60E-03	2 50E-03	2.00E-05	1.30E-06	6 80E-09	4.00E+03	1.07E+00	
Am243+D	20	600	5 40E-03	3.60E-03	2.50E-03	2 00E-05	1.30E-06	6.80E-09	3.70E+02	1.07E+00	
Au-195	20	50	6 40E-05	5.20E-04	3.00E-05	2 60E-06	1.80E-10	8.30E-13	3.13E+04	8.19E+00	
Au-195	20	600	4 50E-04	5 20E-04	3 00E-05	2 60E-06	1 80E-10	8.30E-13	4.44E+03	8.19E+00	
Bi-207	20	50	5.40E-03	3.30E-02	4.60E-03	1.80E-04	4.30E-10	2.20E-12	3 70E+02	1.18E-01	
Bi-207	20	600	6 00E-02	3.30E-02	4 60E-03	1.80E-04	4.30E-10	2.20E-12	3.33E+01	1.18E-01	
C-14	20	600	1.90E-09	7.10E-09	1.10E-08	4 30E-11	5.50E-10	2 80E-12	1.05E+09	4.95E+05	
Ca-41	20	600	0	4.50E-10	6.70E-09	7.60E-12	1.50E-09	7.50E-12	NA	2.80E+06	
Ca-45	20	600	0	2.20E-09	3.70E-08	4.10E-11	7.40E-11	3.70E-13	NA	5.20E+05	
Cd-109	20	50	4.80E-06	3.50E-05	3.40E-06	1.80E-07	5 60E-10	2.90E-12	4.17E+05	1.18E+02	
Cd-109	20	600	4.40E-05	3.50E-05	3.40E-06	1.80E-07	5.60E-10	2.90E-12	4.55E+04	1.18E+02	
Ce-141	20	50	1.80E-04	1.20E-03	1.40E-04	6.40E-06	5.20E-11	3.60E-13	1.11E+04	3.33E+00	
Ce-141	20	600	2.00E-03	1.20E-03	1 40E-04	6.40E-06	5.20E-11	3 60E-13	1.00E+03	3.33E+00	
Ce-144+D	20	50	1.80E-04	1.10E-03	1.50E-04	6 10E-06	1.30E-09	6 80E-12	1.11E+04	3.49E+00	
Ce-144+D	20	600	2.00E-03	1.10E-03	1.50E-04	6.10E-06	1.30E-09	6.80E-12	1.00E+03	3.49E+00	
Cf-252	20	600	2.10E-07	5 30E-05	7.70E-04	8.80E-07	4 80E-07	2.40E-09	9 52E+06	2.42E+01	2.60E+04
Cl-36	20	600	1.40E-05	8 10E-06	1.10E-06	4 40E-08	2.90E-10	1.50E-12	1.43E+05	4 84E+02	
Cm-242	20	600	2.10E-07	6.00E-06	8.50E-05	9.80E-08	5.30E-08	2.70E-10	9.52E+06	2.17E+02	
Cm-243	20	50	3.40E-04	2 40E-03	1.80E-03	1.40E-05	9.70E-07	4.80E-09	5.88E+03	1.52E+00	
Cm-243	20	600	3.80E-03	2.40E-03	1 80E-03	1.40E-05	9.70E-07	4.80E-09	5.26E+02	1.52E+00	
Cm-244	20	600	0	8 30E-05	1.20E-03	1.40E-06	7.60E-07	3.90E-09	NA	1.52E+01	1.67E+04
Cm-248	20	600	4 00E-10	5 50E-04	8.10E-03	9.20E-06	5 00E-06	2.60E-08	5.00E+09	2.32E+00	
Co-57	20	50	2.80E-04	1.90E-03	2 00E-04	1.00E-05	3.40E-10	1 70E-12	7.14E+03	2.13E+00	

Radionuclide	Assumed concentration (pCi/gm)	Driving distance (miles)	Driver (mrem/ shipment)	RCRA drums Receiving worker (mrem/ shipment)	RCRA drums Landfill worker (mrem/ shipment)	RCRA drums Worker population (person-rem)	Offsite individual (mrem/ shipment)	Offsite population (person-rem)	Allowable Concentration Driver-based on 10 shipments/yr (pCi/gm)	Total Activity (Receiving worker <1person-rem/yr) (Ci/yr) (a)	Allowable concentration based on RCRA worker (pCi/gm)
Co-57	20	600	3 00E-03	1 90E-03	2 00E-04	1 00E-05	3.40E-10	1.70E-12	6 67E+02	2.13E+00	
Co-60	20	50	9.20E-03	5 60E-02	7.90E-03	3.00E-04	4.00E-08	2.10E+10	2.17E+02	7.10E-02	
Co-60	20	600	1.00E-01	5 60E-02	7 90E-03	3.00E-04	4.00E-08	2 10E+10	2.00E+01	7.10E-02	
Cs-134	20	50	5.50E-03	3 40E-02	4.70E-03	1 80E-04	1.20E-08	5.90E-11	3 64E+02	1.18E-01	
Cs-134	20	600	6 20E-02	3 40E-02	4 70E-03	1.80E-04	1 20E-08	5.90E-11	3.23E+01	1.18E-01	
Cs-135	20	600	5 20E-08	7 10E-08	2 60E-08	3 80E-10	4 90E+10	2.50E-12	3 85E+07	5.61E+04	
Cs-137+D	20	50	2 00E-03	1.20E-02	8 30E-04	6.70E-05	3 40E-08	1.70E-10	1.00E+03	3.18E-01	
Cs-137+D	20	600	2.20E-02	1.20E-02	8.30E-04	6.70E-05	3.40E-08	1.70E-10	9.09E+01	3.18E-01	
Eu-152	20	50	4.00E-03	2.50E-02	3 50E-03	1.30E-04	4.00E-08	2 10E-10	5.00E+02	1.64E-01	
Eu-152	20	600	4 50E-02	2 50E-02	3 50E-03	1 30E-04	4 00E-08	2 10E-10	4.44E+01	1.64E-01	
Eu-154	20	50	4 30E-03	2.70E-02	3.70E-03	1 50E-04	1.30E-08	1.60E-10	4.65E+02	1.42E-01	
Eu-154	20	600	4.80E-02	2 70E-02	3.70E-03	1.50E-04	1.30E-08	1.60E-10	4.17E+01	1.42E-01	
Eu-155	20	50	7.10E-05	5 50E-04	4 00E-05	2.80E-06	1.10E-09	5 50E-12	2.82E+04	7.61E+00	
Eu-155	20	600	5.80E-04	5 50E-04	4 00E-05	2.80E-06	1.10E-09	5 50E-12	3.45E+03	7.61E+00	
Fe-55	20	600	0	9 00E-10	1.30E-08	1.50E-11	8 60E-12	4.40E-14	NA	1.42E+06	
Fe-59	20	50	4 30E-03	2 60E-02	3.80E-03	1 40E-04	5.50E-10	2.80E-12	4 65E+02	1.52E-01	
Fe-59	20	600	4.90E-02	2.60E-02	3 80E-03	1.40E-04	5.50E-10	2 80E-12	4.08E+01	1.52E-01	
Gd-152	20	600	0	8.20E-05	1.20E-03	1.40E-06	7.50E-07	3 80E-09	NA	1.52E+01	
Gd-153	20	50	4 80E-05	4 30E-04	2.80E-05	2.20E-06	3 30E-10	1.70E-12	4.17E+04	9.68E+00	
Gd-153	20	600	2.60E-04	4.30E-04	2.80E-05	2.20E-06	3.30E-10	1.70E-12	7.69E+03	9.68E+00	
Ge-68+D	20	50	3.30E-03	2.10E-02	2 80E-03	1.10E-04	2.80E-09	1.40E-11	6.06E+02	1.94E-01	
Ge-68+D	20	600	3.70E-02	2.10E-02	2.80E-03	1.10E-04	2.80E-09	1.40E-11	5.41E+01	1.94E-01	
H-3	20	600	0	1.00E-05	3.20E-10	3.60E-13	1.10E-12	5.60E-15	NA	5.92E+07	2 00E+06
I-125	20	600	9.70E-12	8 20E-09	1 60E+07	1.80E-10	1.70E-10	8.70E-13	2.06E+11	1.18E+05	
I-129	20	600	7 10E-10	6 40E-08	8.70E-07	1.00E-09	9.20E-08	4 70E-10	2.82E+09	2.13E+04	
Ir-192	20	50	2.70E-03	1.70E-02	2 30E-03	9 30E-05	6.90E-10	3.50E-12	7 41E+02	2.29E-01	
Ir-192	20	600	3 10E-02	1.70E-02	2 30E-03	9 30E-05	6 90E-10	3.50E-12	6.45E+01	2.29E-01	
K-40	20	50	5.80E-04	3 50E-03	5 10E-04	1.90E-05	8.30E-08	4.20E-10	3.45E+03	1.12E+00	
K-40	20	600	6 50E-03	3.50E-03	5.10E-04	1.90E-05	8.30E-08	4.20E-10	3 08E+02	1.12E+00	
Mn-54	20	50	3.00E-03	1.80E-02	2 50E-03	9.90E-05	2 60E-09	1.30E-11	6 67E+02	2.15E-01	
Mn-54	20	600	3.30E-02	1 80E-02	2.50E-03	9 90E-05	2 60E-09	1.30E-11	6 06E+01	2.15E-01	
Na-22	20	50	7.90E-03	4.90E-02	6.90E-03	2.70E-04	1.80E-08	9.30E-11	2.53E+02	7.89E-02	
Na-22	20	600	9 00E-02	4 90E-02	6 90E-03	2.70E-04	1 80E-08	9.30E-11	2.22E+01	7 89E-02	
Nb-94	20	50	5 60E-03	3 50E-02	4.80E-03	1.90E-04	1.70E-07	8.70E-10	3.57E+02	1.12E-01	

Radionuclide	Assumed concentration (pCi/gm)	Driving distance (miles)	Driver (mrem/ shipment)	RCRA drums Receiving worker (mrem/ shipment)	RCRA drums Landfill worker (mrem/ shipment)	RCRA drums Worker population (person-rem)	Offsite individual (mrem/ shipment)	Offsite population (person-rem)	Allowable Concentration Driver-based on 10 shipments/yr (pCi/gm)	Total Activity (Receiving worker <1person-rem/yr) (Ci/yr) (a)	Allowable concentration based on RCRA worker (pCi/gm)
Nb-94	20	600	6 30E-02	3 50E-02	4 80E-03	1.90E-04	1.70E-07	8.70E-10	3.17E+01	1.12E-01	
Nb-95	20	50	2.70E-03	1.70E-02	2 30E-03	9 10E-05	2.80E-10	1.40E-12	7.41E+02	2.34E-01	
Nb-95	20	600	3.00E-02	1.70E-02	2.30E-03	9.10E-05	2.80E-10	1.40E-12	6.67E+01	2.34E-01	
Ni-59	20	600	0	9 10E-10	1 30E-08	1.50E-11	2.70E-11	1.40E-13	NA	1 42E+06	
Ni-63	20	600	0	2 10E-09	3.10E-08	3.50E-11	6 00E-11	3.00E-13	NA	6 09E+05	
Np-237+D	20	50	6 40E-04	4.30E-03	3 20E-03	2.50E-05	1 70E-06	8.70E-09	3.13E+03	8.52E-01	
Np-237+D	20	600	7 00E-03	4 30E-03	3 20E-03	2 50E-05	1.70E-06	8.70E-09	2.86E+02	8.52E-01	
Pa-231	20	50	1.10E-04	1.20E-03	6 40E-03	1.10E-05	4.00E-06	2 10E-08	1.82E+04	1.94E+00	
Pa-231	20	600	1 30E-03	1 20E-03	6.40E-03	1.10E-05	4 00E-06	2.10E-08	1.54E+03	1.94E+00	
Pb-210+D	20	600	6 40E-07	7.20E-06	6 90E-05	9 00E-08	1 60E-07	8.10E-10	3.13E+06	2.37E+02	
Pm-147	20	600	1 70E-07	1.50E-07	2 00E-07	9 40E-10	1.20E-10	6 20E-13	1.18E+07	2 27E+04	
Po-210	20	600	3.40E-07	3.30E-06	4 50E-05	5.40E-08	2 90E-08	1.50E-10	5 88E+06	3.94E+02	
Pu-238	20	600	2.20E-08	1.30E-04	1 90E-03	2.20E-06	1.20E-06	6.10E-09	9.09E+07	9.68E+00	1.05E+04
Pu-239	20	600	1.60E-06	1.50E-04	2.10E-03	2.40E-06	1.30E-06	6.80E-09	1.25E+06	8.88E+00	9.52E+03
Pu-240	20	600	2.20E-08	1 40E-04	2.10E-03	2 40E-06	1.30E-06	6 80E-09	9.09E+07	8 88E+00	9.52E+03
Pu-241+D	20	600	1.10E-07	2.80E-06	4 10E-05	4.70E-08	2 60E-08	1.30E-10	1.82E+07	4.53E+02	4.88E+05
Pu-242	20	600	3.00E-08	1 40E-04	2.00E-03	2.30E-06	1.20E-06	6 20E-09	6.67E+07	9 26E+00	1.00E+04
Pu-244+D	20	50	4.50E-03	2 80E-02	5 80E-03	1.50E-04	1 30E-06	6.80E-09	4 44E+02	1.42E-01	
Pu-244+D	20	600	5.10E-02	2.80E-02	5 80E-03	1.50E-04	1.30E-06	6.80E-09	3.92E+01	1.42E-01	
Ra-226+D	20	50	6.40E-03	3.90E-02	5 60E-03	2.10E-04	2.50E-07	1.20E-09	3.13E+02	1.01E-01	
Ra-226+D	20	600	7.10E-02	3.90E-02	5 60E-03	2.10E-04	2 50E-07	1.20E-09	2.82E+01	1.01E-01	
Ru-106+D	20	50	7.50E-04	4.70E-03	6 40E-04	2.50E-05	2.30E-09	1.20E-11	2 67E+03	8.52E-01	
Ru-106+D	20	600	8.50E-03	4.70E-03	6 40E-04	2.50E-05	2.30E-09	1.20E-11	2.35E+02	8.52E-01	
S-35	20	600	2.20E-09	8 20E-09	1.30E-08	5.00E-11	2 60E-11	1.30E-13	9.09E+08	4.26E+05	
Sb-124	20	50	6.70E-03	4.10E-02	5 80E-03	2.20E-04	1.10E-09	5.70E-12	2.99E+02	9.68E-02	
Sb-124	20	600	7.50E-02	4.10E-02	5 80E-03	2 20E-04	1.10E-09	5.70E-12	2.67E+01	9.68E-02	
Sb-125+D	20	50	1.40E-03	9 00E-03	1 20E-03	4 90E-05	4.00E-09	2.10E-11	1.43E+03	4.35E-01	
Sb-125+D	20	600	1.60E-02	9 00E-03	1 20E-03	4.90E-05	4.00E-09	2.10E-11	1.25E+02	4.35E-01	
Sc-46	20	50	7.20E-03	4.40E-02	6.30E-03	2.40E-04	1.70E-09	8.70E-12	2.78E+02	8.88E-02	
Sc-46	20	600	8.10E-02	4.40E-02	6.30E-03	2.40E-04	1.70E-09	8.70E-12	2.47E+01	8.88E-02	
Se-75	20	50	1.20E-03	7.60E-03	9 40E-04	4 00E-05	4.90E-10	2.50E-12	1.67E+03	5.33E-01	
Se-75	20	600	1.30E-02	7 60E-03	9 40E-04	4.00E-05	4.90E-10	2.50E-12	1.54E+02	5 33E-01	
Sm-147	20	600	0	2 50E-05	3.70E-04	4.20E-07	2.30E-07	1.20E-09	NA	5.07E+01	5.41E+04
Sm-151	20	600	0	1 00E-08	1.50E-07	1.70E-10	9 60E-11	4.90E-13	NA	1.25E+05	

Radionuclide	Assumed concentration (pCi/gm)	Driving distance (miles)	Driver (mrem/ shipment)	RCRA drums Receiving worker (mrem/ shipment)	RCRA drums Landfill worker (mrem/ shipment)	RCRA drums Worker population (person-rem)	Offsite individual (mrem/ shipment)	Offsite population (person-rem)	Allowable Concentration Driver-based on 10 shipments/yr (pCi/gm)	Total Activity (Receiving worker <1person-rem/yr) (Ci/yr) (a)	Allowable concentration based on RCRA worker (pCi/gm)
Sn-113+D	20	50	8 60E-04	5 40E-03	7.10E-04	2 90E-05	3.60E-10	1 80E-12	2.33E+03	7.34E-01	
Sn-113+D	20	600	9 70E-03	5.40E-03	7 10E-04	2.90E-05	3.60E-10	1.80E-12	2 06E+02	7.34E-01	
Sr-85	20	50	1.70E-03	1.10E-02	1 50E-03	5.90E-05	3 60E-10	1.80E-12	1.18E+03	3 61E-01	
Sr-85	20	600	2.00E-02	1.10E-02	1 50E-03	5.90E-05	3 60E-10	1.80E-12	1.00E+02	3.61E-01	
Sr-89	20	600	5.10E-05	2 90E-05	4.00E-06	1 60E-07	1.50E-10	7 50E-13	3.92E+04	1.33E+02	
Sr-90+D	20	600	0	4.40E-07	1 00E-05	1 10E-08	4.80E-08	2 40E-10	NA	1.94E+03	
Ta-182	20	50	4.50E-03	2 80E-02	3.90E-03	1.50E-04	1.60E-09	8.10E-12	4.44E+02	1.42E-01	
Ta-182	20	600	5.00E-02	2.80E-02	3.90E-03	1.50E-04	1 60E-09	8.10E-12	4.00E+01	1.42E-01	
Tc-99	20	600	5 30E-07	3 80E-07	7 40E-08	2.00E-09	2 00E-09	1.00E-11	3 77E+06	1 07E+04	
Te-125m	20	600	1.10E-05	6 90E-06	6 60E-07	3.60E-08	4 90E-11	2.50E-13	1.82E+05	5 92E+02	
Th-232/Ra-228+D /Th-228+D	20	50	9.10E-03	5 60E-02	1.80E-02	3.10E-04	6.10E-06	3.10E-08	2.20E+02	6 87E-02	
Th-232/Ra-228+D /Th-228+D	20	600	1.10E-01	5 60E-02	1.80E-02	3.10E-04	6.10E-06	3 10E-08	1.82E+01	6 87E-02	
Th229+D	20	50	9 10E-04	6 60E-03	1.10E-02	4.40E-05	6 60E-06	3 40E-08	2.20E+03	4.84E-01	
Th229+D	20	600	1.00E-02	7 80E-04	3 60E-04	1.20E-05	6 60E-06	3.40E-08	2.00E+02	1.78E+00	
Th-230	20	600	4.60E-06	1.10E-04	1 60E-03	1 80E-06	1.00E-06	5 10E-09	4.35E+05	1.18E+01	1.25E+04
Tl-204	20	600	9 70E-06	1 10E-05	7 00E-07	5.40E-08	5.90E-11	3.00E-13	2 06E+05	3.94E+02	
U-232	20	600	3.10E-06	2.20E-04	3 30E-03	3.70E-06	2.10E-06	1.10E-08	6.45E+05	5.76E+00	6.06E+03
U-233	20	600	8.70E-06	5 00E-05	6 70E-04	7.80E-07	4.20E-07	2.10E-09	2.30E+05	2.73E+01	2.99E+04
U-234	20	600	7.70E-07	4.50E-05	6 50E-04	7.40E-07	4.00E-07	2.10E-09	2.60E+06	2.88E+01	3.08E+04
U-235+D	20	50	4.40E-04	3.00E-03	9 50E-04	1.60E-05	3.90E-07	2 00E-09	4.55E+03	1.33E+00	
U-235+D	20	600	4.90E-03	3.00E-03	9.50E-04	1 60E-05	3.90E-07	2 00E-09	4.08E+02	1.33E+00	
U-236	20	600	2.00E-07	4.20E-05	6.20E-04	7.00E-07	3.80E-07	1.90E-09	1.00E+07	3.04E+01	3.23E+04
U-238+D	20	50	7 30E-05	5.10E-04	6.40E-04	3 20E-06	3.70E-07	1.90E-09	2.74E+04	6 66E+00	
U-238+D	20	600	7.80E-04	5.10E-04	6 40E-04	3.20E-06	3.70E-07	1.90E-09	2.56E+03	6.66E+00	
Zn-65	20	50	2.10E-03	1 30E-02	1 80E-03	7 00E-05	1 60E-09	8.10E-12	9 52E+02	3 04E-01	
Zn-65	20	600	2 40E-02	1 30E-02	1.80E-03	7.00E-05	1 60E-09	8.10E-12	8.33E+01	3 04E-01	
Zr-95+D	20	50	2 60E-03	1.60E-02	2.20E-03	8.80E-05	5.40E-10	2.70E-12	7.69E+02	2.42E-01	
Zr-95+D	20	600	2.90E-02	1.60E-02	2.20E-03	8 80E-05	5.40E-10	2.70E-12	6.90E+01	1.52E+01	

(a) The total activity limit per generator does not apply if the RCRA facility receiving the waste has a radioactive material or waste license and all workers are badged as radiation workers

Table 2. Results of RESRAD Analysis for Humid and Dry RCRA Sites.

Radionuclide	Wet Site concentration limit (pCi/gm)	Indoor Radon (pCi/l)	Concentration to not exceed 4 pCi/l (pCi/gm)	Dry Site (pCi/gm)	Indoor Radon (pCi/l)	Concentration to not exceed 4 pCi/l (pCi/gm)
Ac-227+D	NL			NL		
Ag-108+D	NL			NL		
Ag-110m+D	SL			SL		
Al-26	NL			NL		
Am-241	NL			NL		
Am243+D	NL			NL		
Au-195	NL			NL		
Ba-133	NL			NL		
Bi-207	NL			NL		
C-14	5.10E-01			NL		
Ca-41	NL			NL		
Cd-109	NL			NL		
Ce-144+D	SL			SL		
Cf-252	NL			NL		
Cl-36	8.30E-02			2.10E-01		
Cm-243	NL			NL		
Cm-244	NL			NL		
Cm-245	NL			NL		
Cm-246	NL			NL		
Cm-247	NL			NL		
Cm-248	NL			NL		
Co-57	SL			SL		
Co-60	2 63E+11			2.63E+11		
Cs-134	9 85E+13			9 85E+13		
Cs-135	NL			NL		
Cs-137+D	NL			NL		
Eu-152	4.63E+12			4.63E+12		
Eu-154	2.12E+12			2.12E+12		
Eu-155	NL			NL		
Fe-55	NL			NL		
Gd-152	NL			NL		
Gd-153	NL			NL		
Ge-68+D	NL			NL		
H-3	1.95E+01			4 67E+15		
I-129	2.10E-02			NL		
K-40	NL			NL		
Mn-54	3.75E+13			3 75E+13		
Na-22	7.61E+12			7.61E+12		
Nb93m	NL			NL		
Nb-94	NL			NL		
Ni-59	NL			NL		
Ni-63	NL			NL		
Np-237+D	NL			NL		
Pa-231	NL			NL		

Radionuclide	Wet Site concentration limit (pCi/gm)	Indoor Radon (pCi/l)	Concentration to not exceed 4 pCi/l (pCi/gm)	Dry Site (pCi/gm)	Indoor Radon (pCi/l)	Concentration to not exceed 4 pCi/l (pCi/gm)
Pb-210+D	NL			NL		
Pm-147	NL			NL		
Pu-238	NL	2.25E-06	1.78E+08	NL	2.30E-06	1.74E+08
Pu-239	NL			NL		
Pu-240	NL			NL		
Pu-241+D	NL			NL		
Pu-242	NL			NL		
Pu-244+D	NL			NL		
Ra-226+D	NL	4 99E+00	8 02E+01	NL	3.22E+00	1.24E+02
Ra-228	2.05E+11			2.05E+11		
Ru-106+D	2.50E+15			2.50E+15		
Sb-125+D	NL			NL		
Se-79	NL			NL		
Sm-147	NL			NL		
Sm-151	NL			NL		
Sr-90+D	NL			NL		
Tc-99	8.80E-01			NL		
Th-228+D	1.42E+11			1.42E+11		
Th229+D	NL			NL		
Th-230	NL	1.75E+00	2.29E+02	NL	1.74E+00	2.30E+02
Th-232	NL			NL		
Tl-204	NL			NL		
U-232	1.32E+11			1.32E+11		
U-233	NL			NL		
U-234	NL	8 06E-03	4 96E+04	NL	8 12E-03	4 93E+04
U-235+D	NL			NL		
U-236	NL			NL		
U-238+D	NL	7.76E-06	5.15E+07	NL	8 01E-06	4.99E+07
Zn-65	SL			SL		
Zr-93	NL			NL		

Table 3 Integrated results of RCRA and TSD-DOSE Analysis

Radionuclide	Allowable Concentration based on <50 mile driving distance (pCi/gm)	Allowable Concentration based on >50 mile driving distance (pCi/gm)	Total Activity (Receiving worker <1mem/yr) (Ci/yr)	Allowable concentration based on RCRA worker (pCi/gm)	Allowable Concentration at humid RCRA site (pCi/gm)	Concentration to not exceed 4 pCi/l (pCi/gm)	Allowable Concentration at dry RCRA site (pCi/gm)	Concentration to not exceed 4 pCi/l (pCi/gm)	Allowable concentration based on IAEA exempt transport limits (pCi/gm)	Allowable concentration based on TDH unrestricted soil limits (pCi/gm)
Ac-227+D	1 67E+03	1.54E+02	2 73E-01		NL		NL			
Ag-108+D	3.57E+02	3 23E+01	1.12E-01		NL		NL			
Ag-110m+D	2.02E+02	1.82E+01	6.45E-02		SL		SL			
Al-26	2 04E+02	1 67E+01	6 45E-02		NL		NL			
Am-241			7 61E+00	9.09E+03	NL		NL		2.70E+01	6.00E+00
Am243+D			1 07E+00		NL		NL		2.70E+01	
Au-195	3 13E+04	4.44E+03	8.19E+00		NL		NL			
Ba-133					NL		NL		2.70E+03	
Bi-207	3.70E+02	3 33E+01	1.18E-01		NL		NL			
C-14					5.10E-01		NL		2.70E+05	8.00E+02
Ca-41					NL		NL		2.70E+06	
Ca-45					SL					
Cd-109	4.17E+05	4.55E+04	1.18E+02		NL		NL			
Ce-141	1.11E+04	1.00E+03	3.33E+00		SL					
Ce-144+D	1.11E+04	1.00E+03	3.49E+00		SL		SL			
Cf-252			2.42E+01	2.60E+04	NL		NL		2.70E+01	
Cl-36					8.30E-02		2.10E-01		2.70E+05	
Cm-242			2.17E+02						2.70E+01	
Cm-243	5.88E+03	5.26E+02	1.52E+00		NL		NL		2.70E+01	
Cm-244			1.52E+01	1.67E+04	NL		NL		2.70E+01	
Cm-245					NL		NL		2.70E+01	
Cm-246					NL		NL		2.70E+01	
Cm-247					NL		NL		2.70E+01	
Cm-248			2.32E+00		NL		NL		2.70E+01	
Co-57	7.14E+03	6.67E+02	2.13E+00		SL		SL			
Co-60	2.17E+02	2.00E+01	7.10E-02		2 63E+11		2.63E+11			
Cs-134	3 64E+02	3.23E+01	1.18E-01		9.85E+13		9.85E+13			
Cs-135					NL		NL		2.70E+05	

Cs-137+D	1.00E+03	9 09E+01	3.18E-01		NL		NL			
Eu-152	5 00E+02	4.44E+01	1.64E-01		4 63E+12		4.63E+12			
Eu-154	4 65E+02	4.17E+01	1.42E-01		2.12E+12		2.12E+12			
Eu-155	2.82E+04	3.45E+03	7.61E+00		NL		NL			
Fe-55					NL		NL		2.70E+05	2 00E+03
Fe-59	4.65E+02	4 08E+01	1.52E-01		SL					
Gd-152			1.52E+01		NL		NL			
Gd-153	4.17E+04	7.69E+03	9.68E+00		NL		NL			
Ge-68+D	6 06E+02	5.41E+01	1.94E-01		NL		NL			
H-3				2 00E+06	1.95E+01		4 67E+15		2.70E+07	3 00E+03
I-125					SL					
I-129					2.10E-02		NL		2.70E+03	2.00E+00
Ir-192	7 41E+02	6.45E+01	2 29E-01							
K-40	3 45E+03	3 08E+02	1.12E+00		NL		NL			
Mn-54	6 67E+02	6 06E+01	2.15E-01		3.75E+13		3.75E+13			
Na-22	2.53E+02	2.22E+01	7.89E-02		7 61E+12		7.61E+12			
Nb93m					NL		NL		2.70E+05	
Nb-94	3.57E+02	3.17E+01	1.12E-01		NL		NL			
Nb-95	7.41E+02	6.67E+01	2.34E-01		SL					
Ni-59					NL		NL		2.70E+05	
Ni-63					NL		NL		2.70E+06	7.00E+02
Np-237+D	3.13E+03	2.86E+02	8.52E-01		NL		NL		2.70E+01	
Pa-231	1.82E+04	1.54E+03	1.94E+00		NL		NL			
Pb-210+D			2.37E+02		NL		NL		2.70E+02	
Pm-147					NL		NL		2.70E+05	2.00E+02
Po-210			3.94E+02						2.70E+02	
Pu-238			9 68E+00	1.05E+04	NL	1.78E+08	NL	1.74E+08	2.70E+01	6.00E+00
Pu-239			8 88E+00	9.52E+03	NL		NL		2.70E+01	6.00E+00
Pu-240			8.88E+00	9.52E+03	NL		NL		2.70E+01	6.00E+00
Pu-241+D			4.53E+02	4.88E+05	NL		NL		2.70E+01	
Pu-242			9.26E+00	1.00E+04	NL		NL		2.70E+01	
Pu-244+D	4.44E+02	3.92E+01	1.42E-01		NL		NL		2.70E+01	
Ra-226+D	3.13E+02	2.82E+01	1.01E-01		NL	8.02E+01	NL	1.24E+02		
Ra-228+D	Included under Th-232				2.05E+11			2.05E+11		

Ru-106+D	2 67E+03	2 35E+02	8 52E-01		2 50E+15		2 50E+15			
S-35					SL					
Sb-124	2 99E+02	2 67E+01	9.68E-02		SL					
Sb-125+D	1.43E+03	1.25E+02	4.35E-01		NL		NL			
Sc-46	2.78E+02	2.47E+01	8.88E-02		SL					
Se-75	1 67E+03	1.54E+02	5 33E-01		SL					
Se-79					NL		NL		2.70E+05	
Sm-147			5 07E+01	5 41E+04	NL		NL		2.70E+02	
Sm-151					NL		NL		2.70E+05	
Sn-113+D	2 33E+03	2.06E+02	7.34E-01		SL					
Sr-85	1.18E+03	1.00E+02	3.61E-01		SL					
Sr-89	3 92E+04		1.33E+02		SL					
Sr-90+D			1.94E+03		NL		NL		2.70E+03	4.00E+01
Ta-182	4.44E+02	4.00E+01	1 42E-01							
Tc-99					8.80E-01		NL		2.70E+05	2.00E+02
Te-125m			5.92E+02						2.70E+04	
Th-228+D	Included under Th-232				1.42E+11			1 42E+11		
Th229+D	2 20E+03	2.00E+02	4 84E-01		NL		NL			
Th-230			1.18E+01	1.25E+04	NL	2.29E+02	NL	2.30E+02	2.70E+01	
Th-232+all D	2.20E+02	1.82E+01	6 87E-02		NL		NL			
Tl-204			3.94E+02		NL		NL		2.70E+05	6 00E+01
U-232			5.76E+00	6 06E+03	1 32E+11		1.32E+11		2.70E+01	
U-233			2.73E+01	2.99E+04	NL		NL		2.70E+02	
U-234			2.88E+01	3.08E+04	NL	4.96E+04	NL	4.93E+04	2.70E+02	6.00E+00
U-235+D	4.55E+03	4.08E+02	1.33E+00		NL		NL		2.70E+02	
U-236			3 04E+01	3.23E+04	NL		NL		2.70E+02	
U-238+D	2.74E+04	2.56E+03	6 66E+00		NL	5.15E+07	NL	4.99E+07	2.70E+02	8 00E+00
Zn-65	9 52E+02	8.33E+01	3 04E-01		SL		SL			
Zr-93					NL		NL		2.70E+04	
Zr-95+D	7.69E+02	6.90E+01	2.42E-01							

Table 4. Final Summary of Concentration and Activity Limits

Radionuclide	Allowable Concentration based on <50 mile driving distance (pCi/gm)	Allowable Concentration based on >50 mile driving distance (pCi/gm)	Total Activity per licensee per year (Ci/yr) (a)	Allowable Concentration at humid RCRA site (pCi/gm)	Allowable Concentration at dry RCRA site (pCi/gm) (b)
Ac-227+D	1667	154	0 27		
Ag-108+D	357	32	0.11		
Al-26	204	17	0.065		
Am-241			7.6	27	27
Am243+D			1.1	27	27
Au-195	31250	4440	8.2		
Ba-133				2700	2700
Bi-207	370	33	0.12		
C-14				0.51	270000
Ca-41				2700000	2700000
Cd-109	416700	45450	118 3		
Cf-252				27	27
Cl-36				0 08	0.2
Cm-242				27	27
Cm-243			1.5	27	27
Cm-244				27	27
Cm-245				27	27
Cm-246				27	27
Cm-247				27	27
Cm-248			2.3	27	27
Co-60	217	20	0 071		
Cs-134	364	32	0 12		
Cs-135				270000	270000
Cs-137+D	1000	91	0.32		
Eu-152	500	44	0 16		
Eu-154	465	42	0 14		
Eu-155	28170	3450	7.6		
Fe-55				270000	270000
Gd-153	41670	7690	9.7		
Ge-68+D	606	54	0.19		
H-3				19.5	2000000
I-129				0 021	2700
Ir-192	740	65	0.23		
K-40	3450	308	1.1		
Mn-54	667	61	0.22		
Na-22	253	22	0 079		
Nb93m				270000	270000
Nb-94	357	32	0 11		
Ni-59				270000	270000
Ni-63				2700000	2700000
Np-237+D			0 85	27	27

Pa-231	18180	1540	1 9		
Pb-210+D				270	270
Pm-147				270000	270000
Po-210(U8)				270	270
Pu-238			9.7	27	27
Pu-239			8.9	27	27
Pu-240			8.9	27	27
Pu-241+D				27	27
Pu-242			9 3	27	27
Pu-244+D			0.14	27	27
Ra-226+D		28	0 1	80	124
Ru-106+D	2670	235	0.85		
Sb-125+D	1430	125	0 43		
Se-79				270000	270000
Sm-147				270	270
Sm-151				270000	270000
Sr-90+D				2700	2700
Ta-182	444	40	0.14		
Tc-99				0 88	270000
Te-125m				27000	27000
Th229+D	2200	200	0 48		
Th-230			11.8	229	230
Th-232+all D*	220	18	0.069		
Tl-204				270000	270000
U-232			5.8	27	27
U-233				270	270
U-234				270	270
U-235+D			1.3	270	270
U-236				270	270
U-238+D			6.6	270	270
Zr-93				27000	27000

* Includes Ra-228+D and Th-228+D

(a) The total activity limit per generator does not apply if the RCRA facility receiving the waste has a radioactive material or waste license and all workers are badged as radiation workers.

(b) A dry RCRA site is defined as meeting all the following requirements: (1) average rainfall less than 15 inches per year; (2) regional aquifer is at least 300 feet below the disposal cell; and (3) permeability of the vadose zone is less than 1.0E-07 cm/sec.

For other radionuclides not included in Table 3, the maximum allowable concentrations will be the effluent concentrations in Table II, Column 2 of 25 TAC 289.202(ggg)(2)(F) of this section, with the units changed from microcuries per milliliter to microcuries per gram.

In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this paragraph shall be determined as follows: For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in this paragraph for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Attachment A

TSD-DOSE Analysis Reports for Short and Long Transportation Distances

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

Version 2.22 - September 1998

Site: WCS
Shipment: Short distance (50 miles) transport and disposal of low activity waste at a RCRA facility
User: wpd

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	9.2E-03 mrem	9.2E-03 mrem	0.0E+00 mrem
Receiving worker:	5.6E-02 mrem	5.6E-02 mrem	7.4E-08 mrem
Incineration worker:	2.9E-02 mrem	2.9E-02 mrem	0.0E+00 mrem
Landfill worker:	7.9E-03 mrem	7.9E-03 mrem	1.1E-06 mrem
Offsite individual:	4.0E-08 mrem		
Offsite population:	2.1E-10 p-rem		
Worker Population:	3.0E-04 p-rem	3.0E-04 p-rem	1.2E-09 p-rem
Dose from:			
Transport to TSD facility:	9.2E-03 mrem	9.2E-03 mrem	not applicable
Receiving and sampling waste:	2.6E-02 mrem	2.6E-02 mrem	7.4E-08 mrem
Storage before processing:	2.9E-02 mrem	2.9E-02 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	7.9E-03 mrem	7.9E-03 mrem	1.1E-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	Co60
Activity	2.1E-04 Ci
Release Fraction	1.00E-02
Driver	9.2 E-03
Receiving worker	5.6 E-02
Incineration worker	not applicable
Landfill worker	7.9 E-03
Offsite individual	4 0 E-08
Offsite population	2.1 E-10
Worker population	3 0 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 = 1.0 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 84E+01 feet (D)
width: 7.30E+00 feet (D)
height: 2.80E+00 feet (D)

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration: 1.00E+00 hours
shielding thickness: 6 25E-02 inches (D)

Step B: Drive
average distance 7.00E+00 feet (D)
duration: 1 00E+00 hours
shielding thickness 1 25E-01 inches (D)

Step C: Rest
average distance 2 00E+00 feet (D)
duration: 0 00E+00 hours
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3 00E+00 feet (D)
duration: 0 00E+00 hours
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: 2 50E-01 hours

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-03 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-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5 00E-01 feet (D)
time per drum. 0 00E+00 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance 5 00E+00 feet
duration· 5.00E+00 hours

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 0 00E+00 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-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: Long distance (600 miles) transport and disposal of low activity waste at a RCRA facility
User: wpd

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.0E-01 mrem	1.0E-01 mrem	0.0E+00 mrem
Receiving worker:	5.6E-02 mrem	5.6E-02 mrem	7.4E-08 mrem
Incineration worker:	2.9E-02 mrem	2.9E-02 mrem	0.0E+00 mrem
Landfill worker:	7.9E-03 mrem	7.9E-03 mrem	1.1E-06 mrem
Offsite individual:	4.0E-08 mrem		
Offsite population:	2.1E-10 p-rem		
Worker Population:	4.0E-04 p-rem	4.0E-04 p-rem	1.2E-09 p-rem
Dose from:			
Transport to TSD facility:	1.0E-01 mrem	1.0E-01 mrem	not applicable
Receiving and sampling waste:	2.6E-02 mrem	2.6E-02 mrem	7.4E-08 mrem
Storage before processing:	2.9E-02 mrem	2.9E-02 mrem	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	7.9E-03 mrem	7.9E-03 mrem	1.1E-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	Co60
Activity	2.1E-04 Ci
Release Fraction	1 00E-02
Driver	1 0 E-01
Receiving worker	5 6 E-02
Incineration worker	not applicable
Landfill worker	7.9 E-03
Offsite individual	4 0 E-08
Offsite population	2.1 E-10
Worker population	4 0 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 = 1.0 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: 1.84E+01 feet (D)
width. 7.30E+00 feet (D)
height 2 80E+00 feet (D)

Step A: Load and secure shipment
average distance: 3.00E+00 feet (D)
duration 1.00E+00 hours
shielding thickness: 6 25E-02 inches (D)

Step B: Drive
average distance: 7 00E+00 feet (D)
duration: 1.20E+01 hours
shielding thickness: 1 25E-01 inches (D)

Step C: Rest
average distance: 2 00E+00 feet (D)
duration: 8 00E+00 hours
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3 00E+00 feet (D)
duration: 1 00E+00 hours
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: 2 50E-01 hours

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-03 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-01 hours (D)

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum 0.00E+00 hours

Storage before processing (3 steps)

Step A: Workers in solid waste storage area
average distance: 5.00E+00 feet
duration: 5.00E+00 hours

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 0.00E+00 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-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 B

RESRAD Analysis Reports for a Humid RCRA Site

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 1995 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	H-3	6.400E-08	6.400E-08	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	H-3	6.400E-08	6.400E-08	DCF3(1)
D-34	Food transfer factors:			
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(1,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(1,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	5.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.000E+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)	1.000E+00	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	3.200E+01	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	5.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	3.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+05	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): H-3	1.000E+02	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	3.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.200E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	7.100E-06	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.400E+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)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.500E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	8.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-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)	1.400E+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
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)	1.180E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	2	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.800E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.200E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.100E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.300E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	1.140E+01	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.000E-02	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	4.000E+00	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.200E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	4.100E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	2.300E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	2.000E-01	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	1.140E+01	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	1.000E-02	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.386E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	1.169E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	3.140E-06	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	5.512E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.571E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.101E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	1.120E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.140E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	2.330E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.510E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	2.060E+01	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)	1.826E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	4.785E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	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	---	FIPW
R018	Contamination fraction of aquatic food	1.000E+00	5.000E-01	---	FR9
R018	Contamination fraction of plant food	1.000E+00	-1	---	FPLANT
R018	Contamination fraction of meat	1.000E+00	-1	---	FMEAT
R018	Contamination fraction of milk	1.000E+00	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	2.710E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	6.325E+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)	6.000E+01	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	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)	2.500E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	1.230E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	1.500E-01	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	C02F
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	0.000E+00	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for risk	1	---	---	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	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	5000.00 square meters	H-3	1.000E+02
Thickness:	4.00 meters		
Cover Depth:	3.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.000E+00 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
TDOSE(t):	0.000E+00	0.000E+00	1.327E+00	2.199E-01	2.458E-03	3.838E-11	5.994E-19	0.000E+00	0.000E+00	0.000E+00
M(t):	0.000E+00	0.000E+00	1.327E+00	2.199E-01	2.458E-03	3.838E-11	5.994E-19	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 5.137E+00 mrem/yr at t = 14.56 ± 0.03 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.456E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 1.456E+01 years

Water Dependent Pathways

Radio-Nuclide	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.
H-3	3.050E+00	0.5937	3.823E-03	0.0007	0.000E+00	0.0000	7.295E-01	0.1420	2.254E-01	0.0439	1.128E+00	0.2197	5.137E+00	1.0000
Total	3.050E+00	0.5937	3.823E-03	0.0007	0.000E+00	0.0000	7.295E-01	0.1420	2.254E-01	0.0439	1.128E+00	0.2197	5.137E+00	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.00OE+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	0.00OE+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	7.871E-01	0.5932	9.884E-04	0.0007	0.000E+00	0.0000	1.890E-01	0.1425	5.852E-02	0.0441	2.913E-01	0.2195	1.327E+00	1.0000
Total	7.871E-01	0.5932	9.884E-04	0.0007	0.000E+00	0.0000	1.890E-01	0.1425	5.852E-02	0.0441	2.913E-01	0.2195	1.327E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 5.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	1.304E-01	0.5932	1.638E-04	0.0007	0.000E+00	0.0000	3.132E-02	0.1425	9.698E-03	0.0441	4.827E-02	0.2195	2.199E-01	1.0000
Total	1.304E-01	0.5932	1.638E-04	0.0007	0.000E+00	0.0000	3.132E-02	0.1425	9.698E-03	0.0441	4.827E-02	0.2195	2.199E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	1.458E-03	0.5932	1.831E-06	0.0007	0.000E+00	0.0000	3.501E-04	0.1425	1.084E-04	0.0441	5.396E-04	0.2195	2.458E-03	1.0000
Total	1.458E-03	0.5932	1.831E-06	0.0007	0.000E+00	0.0000	3.501E-04	0.1425	1.084E-04	0.0441	5.396E-04	0.2195	2.458E-03	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	2.277E-11	0.5932	2.859E-14	0.0007	0.000E+00	0.0000	5.468E-12	0.1425	1.693E-12	0.0441	8.427E-12	0.2195	3.838E-11	1.0000
Total	2.277E-11	0.5932	2.859E-14	0.0007	0.000E+00	0.0000	5.468E-12	0.1425	1.693E-12	0.0441	8.427E-12	0.2195	3.838E-11	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 5.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	3.555E-19	0.5932	4.465E-22	0.0007	0.000E+00	0.0000	8.539E-20	0.1425	2.644E-20	0.0441	1.316E-19	0.2195	5.994E-19	1.0000
Total	3.555E-19	0.5932	4.465E-22	0.0007	0.000E+00	0.0000	8.539E-20	0.1425	2.644E-20	0.0441	1.316E-19	0.2195	5.994E-19	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 3.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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+05 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	0.000E+00	0.000E+00	1.327E-02	2.199E-03	2.458E-05	3.838E-13	5.994E-21	1.827E-40	0.000E+00	0.000E+00

*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 ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.000E+00 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	*9.594E+15	*9.594E+15	7.536E+01	4.548E+02	4.068E+04	2.605E+12	*9.594E+15	*9.594E+15	*9.594E+15	*9.594E+15

*At specific activity limit

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 = 14.56 ± 0.03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
H-3	1.000E+02	14.56 ± 0.03	5.137E-02	1.947E+01	5.137E-02	1.947E+01

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	0.000E+00	0.000E+00	1.327E+00	2.199E-01	2.458E-03	3.838E-11	5.994E-19	0.000E+00	0.000E+00	0.000E+00

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

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	1.000E+02	9.139E+01	6.724E+00	1.112E+00	1.237E-02	1.891E-10	2.891E-18	8.356E-38	0.000E+00	0.000E+00

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

RESCALC.EXE execution time = 0.38 seconds

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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+05 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	0.000E+00	0.000E+00	1.327E-02	2.199E-03	2.458E-05	3.838E-13	5.994E-21	1.827E-40	0.000E+00	0.000E+00

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

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.000E+00 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	*9.594E+15	*9.594E+15	7.536E+01	4.548E+02	4.068E+04	2.605E+12	*9.594E+15	*9.594E+15	*9.594E+15	*9.594E+15

*At specific activity limit

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 = 14.56 ± 0.03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
H-3	1.000E+02	14.56 ± 0.03	5.137E-02	1.947E+01	5.137E-02	1.947E+01

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	0.000E+00	0.000E+00	1.327E+00	2.199E-01	2.458E-03	3.838E-11	5.994E-19	0.000E+00	0.000E+00	0.000E+00

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

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
H-3	H-3	1.000E+00	1.000E+02	9.139E+01	6.724E+00	1.112E+00	1.237E-02	1.891E-10	2.891E-18	8.356E-38	0.000E+00	0.000E+00

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

RESCALC.EXE execution time = 0.38 seconds

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)art II: Source Terms, Factors, and Parameters for Individual Pathways

Parameters Used for Calculating Indoor and Outdoor Radon Flux

	*Floor Material	Cover Material	Contaminated Zone
Radon Diffusion Coefficient (m**2/s)	3.000E-07	2.000E-06	2.000E-06
Total Porosity	1.000E-01	4.000E-01	4.000E-01
Volumetric Water Content	3.000E-02	5.000E-02	2.644E-01
Bulk Density (g/cm**3)	2.400E+00	1.200E+00	1.400E+00
Rn-222 Emanation Coefficient	2.500E-01	2.500E-01	2.500E-01
Initial Thickness (m)	1.500E-01	3.000E+00	4.000E+00

Building Depth Below Ground Surface *(DMFL): -1.000E+00 (m)
Negative DMFL shows building depth adjusted (if necessary) for no penetration
of contaminated zone. Actual values used *(DMFLACT), m:

t=	0.0000E+00	1.0000E+00	3.0000E+01	5.0000E+01	1.0000E+02	3.0000E+02	5.0000E+02	1.0000E+03	3.0000E+03	1.0000E+05
DMFLACT=	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00

Building indoor area factor *(FAI): 0.000E+00
FAI <= 0.0 shows calculated time-dependent value based on amount of wall area
extending into the contaminated zone. Actual values used *(FAIACT):

t=	0.0000E+00	1.0000E+00	3.0000E+01	5.0000E+01	1.0000E+02	3.0000E+02	5.0000E+02	1.0000E+03	3.0000E+03	1.0000E+05
FAIACT =	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00

* - Parameters are used only for indoor radon flux

Time Dependence of Outdoor Radon Flux [FLUXO(i,t)]

Nuclide	FLUXO(i,t) (pCi/m**2/s)									
(i) t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	3.3169E+00	3.3154E+00	3.2735E+00	3.2449E+00	3.1745E+00	2.9079E+00	2.6636E+00	2.1389E+00	8.8944E-01	2.9316E-19

Time Dependence of Indoor Radon Flux [FLUXI(i,t)]

Nuclide	FLUXI(i,t) (pCi/m**2/s)									
(i) t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	1.7484E+00	1.7477E+00	1.7256E+00	1.7105E+00	1.6734E+00	1.5328E+00	1.4040E+00	1.1275E+00	4.6884E-01	1.5463E-19

Parameters Used for Calculating Indoor and Outdoor Radon Concentration

Radon Vertical Dimension of Mixing (HMIX):	2.000E+00	(m)
Average Annual Wind Speed (WIND):	2.000E+00	(m/sec)
Building Room Height (HRM):	2.500E+00	(m)
Building Air Exchange Rate (REXG):	5.000E-01	(1/hr)

Time Dependence of Outdoor Radon Concentration [CRNO(i,t)]

Nuclide		CRNO(i,t) (pCi/m**3)									
(i)	t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	2.9317E+01	2.9304E+01	2.8934E+01	2.8681E+01	2.8059E+01	2.5702E+01	2.3542E+01	1.8905E+01	7.8615E+00	2.5912E-18

Time Dependence of Indoor Radon Concentration [HCONC(i,r)]

Nuclide		HCONC(i,t) (pCi/m**3)									
(i)	t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	4.9893E+03	4.9872E+03	4.9241E+03	4.8811E+03	4.7752E+03	4.3740E+03	4.0066E+03	3.2174E+03	1.3379E+03	4.4125E-16

Outdoor Working Levels of Radon [WLOTD(i,t)]

Nuclide (i)	t=	WLOTD(i,t) (WL) 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		1.0012E-06	1.0007E-06	9.8808E-07	9.7945E-07	9.5819E-07	8.7770E-07	8.0396E-07	6.4561E-07	2.6847E-07	8.8488E-26

Indoor Working Levels of Radon [WLIND(i,t)]

Nuclide (i)	t=	WLIND(i,t) (WL) 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		3.4405E-02	3.4390E-02	3.3955E-02	3.3658E-02	3.2928E-02	3.0162E-02	2.7628E-02	2.2186E-02	9.2256E-03	3.0427E-21

Fraction of Time Spent Outdoors (FOTD): 1.101E-01
Fraction of Time Spent Indoors (FIND): 6.571E-01

Dose/Source Ratios for Radon Pathway (p=9)
Subpathway: Outdoor and Indoor Radon Flux
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,9,t) - DSRRNW(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	Ra-226	1.000E+00	8.730E+00	8.727E+00	8.616E+00	8.541E+00	8.356E+00	7.654E+00	7.011E+00	5.630E+00	2.341E+00	7.721E-19
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	∑DSR(j)		8.730E+00	8.727E+00	8.616E+00	8.541E+00	8.356E+00	7.654E+00	7.011E+00	5.630E+00	2.341E+00	7.721E-19

*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 ≤ 0.5 yr) daughters.

Dose/Source Ratios for Radon Pathway (p=9)
Subpathway: Indoor Radon from Water Usage
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSRRNW(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	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	∑DSR(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

*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 ≤ 0.5 yr) daughters.

Attachment C

RESRAD Analysis Reports for a Dry RCRA Site

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 1995 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cl-36	2.190E-05	2.190E-05	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cl-36	3.030E-06	3.030E-06	DCF3(1)
D-34	Food transfer factors:			
D-34	Cl-36 , plant/soil concentration ratio, dimensionless	2.000E+01	2.000E+01	RTF(1,1)
D-34	Cl-36 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	6.000E-02	6.000E-02	RTF(1,2)
D-34	Cl-36 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cl-36 , fish	1.000E+03	1.000E+03	BIOFAC(1,1)
D-5	Cl-36 , crustacea and mollusks	1.900E+02	1.900E+02	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	5.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.000E+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)	1.000E+00	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	3.000E+01	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	5.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	3.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+05	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cl-36	1.000E+02	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Cl-36	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	3.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.200E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.800E-06	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.400E+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	9.500E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.710E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-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)	1.400E+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
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)	1.180E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	2	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.800E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.200E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.200E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	1.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	1.140E+01	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.000E-02	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	9.100E+01	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.200E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	4.200E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	1.400E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	2.000E-01	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	1.140E+01	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	3.000E-02	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for Cl-36				
R016	Contaminated zone (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	1.000E-01	1.000E-01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.340E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	1.169E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	3.140E-06	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	5.512E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.571E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.101E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	1.120E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.140E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	2.330E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.510E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.826E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	4.785E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	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	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	1.000E+00	-1	---	FPLANT
R018	Contamination fraction of meat	1.000E+00	-1	---	FMEAT
R018	Contamination fraction of milk	1.000E+00	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	2.710E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	6.325E+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)	6.000E+01	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	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)	2.500E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	1.230E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	1.500E-01	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	0.000E+00	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for risk	1	---	---	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	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	5000.00 square meters	Cl-36	1.000E+02
Thickness:	4.00 meters		
Cover Depth:	3.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.000E+00 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
TDOSE(t):	1.602E-22	1.580E-22	1.072E-22	8.208E-23	4.206E-23	2.901E-24	2.001E-25	2.316E+01	6.669E-11	0.000E+00
M(t):	1.602E-22	1.580E-22	1.072E-22	8.208E-23	4.206E-23	2.901E-24	2.001E-25	2.316E+01	6.669E-11	0.000E+00

Maximum TDOSE(t): 4.763E+02 mrem/yr at t = 772 ± 2 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 = 7.724E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Cl-36	5.239E-27	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.00OE+00	0.0000	0.000E+00	0.0000
Total	5.239E-27	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.00OE+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 = 7.724E+02 years

Water Dependent Pathways

Radio-Nuclide	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.
Cl-36	7.353E+01	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	7.381E+01	0.1550	9.771E+01	0.2051	2.313E+02	0.4855	4.763E+02	1.0000
Total	7.353E+01	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	7.381E+01	0.1550	9.771E+01	0.2051	2.313E+02	0.4855	4.763E+02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	1.602E-22	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.602E-22	1.0000	0.000E+00	0.0000	0.000E+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 = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.602E-22	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.602E-22	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	1.580E-22	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.580E-22	1.0000	0.000E+00	0.0000	0.000E+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+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.580E-22	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.580E-22	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	1.072E-22	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.072E-22	1.0000	0.000E+00	0.0000	0.000E+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 = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.072E-22	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.072E-22	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	8.208E-23	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	8.208E-23	1.0000	0.000E+00	0.0000	0.000E+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 = 5.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.208E-23	1.0000
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	8.208E-23	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	4.206E-23	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.206E-23	1.0000	0.000E+00	0.0000	0.000E+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+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.206E-23	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.206E-23	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	2.901E-24	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.901E-24	1.0000	0.000E+00	0.0000	0.000E+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 = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.901E-24	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.901E-24	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	2.001E-25	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.001E-25	1.0000	0.000E+00	0.0000	0.000E+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 = 5.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.001E-25	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.001E-25	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	2.500E-28	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.500E-28	0.0000	0.000E+00	0.0000	0.000E+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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	3.576E+00	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	3.589E+00	0.1550	4.751E+00	0.2051	1.125E+01	0.4855	2.316E+01	1.0000
Total	3.576E+00	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	3.589E+00	0.1550	4.751E+00	0.2051	1.125E+01	0.4855	2.316E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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 = 3.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	1.030E-11	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-11	0.1550	1.368E-11	0.2051	3.238E-11	0.4855	6.669E-11	1.0000
Total	1.030E-11	0.1544	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-11	0.1550	1.368E-11	0.2051	3.238E-11	0.4855	6.669E-11	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+05 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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+05 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cl-36	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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

*Sum of all water independent and dependent pathways.

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

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Cl-36	Cl-36	1.000E+00	1.602E-24	1.580E-24	1.072E-24	8.208E-25	4.206E-25	2.901E-26	2.001E-27	2.316E-01	6.669E-13	0.000E+00

*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 ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.000E+00 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Cl-36	*3.301E+10	*3.301E+10	*3.301E+10	*3.301E+10	*3.301E+10	*3.301E+10	*3.301E+10	4.317E+00	*3.301E+10	*3.301E+10

*At specific activity limit

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 = 772 ± 2 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cl-36	1.000E+02	772 ± 2	4.763E+00	2.099E-01	4.763E+00	2.099E-01

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

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Cl-36	Cl-36	1.000E+00	1.602E-22	1.580E-22	1.072E-22	8.208E-23	4.206E-23	2.901E-24	2.001E-25	2.316E+01	6.669E-11	0.000E+00

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

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g									
		t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Cl-36	Cl-36	1.000E+00	1.000E+02	9.867E+01	6.690E+01	5.117E+01	2.619E+01	1.796E+00	1.231E-01	1.516E-04	3.487E-16	0.000E+00

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

RESCALC.EXE execution time = 0.44 seconds

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Part II: Source Terms, Factors, and Parameters for Individual Pathways

Parameters Used for Calculating Indoor and Outdoor Radon Flux

	*Floor Material	Cover Material	Contaminated Zone
Radon Diffusion Coefficient (m**2/s)	3.000E-07	2.000E-06	2.000E-06
Total Porosity	1.000E-01	4.000E-01	4.000E-01
Volumetric Water Content	3.000E-02	5.000E-02	2.543E-01
Bulk Density (g/cm**3)	2.400E+00	1.200E+00	1.400E+00
Rn-222 Emanation Coefficient	2.500E-01	2.500E-01	2.500E-01
Initial Thickness (m)	1.500E-01	3.000E+00	4.000E+00

Building Depth Below Ground Surface *(DMFL): -1.000E+00 (m)
Negative DMFL shows building depth adjusted (if necessary) for no penetration
of contaminated zone. Actual values used *(DMFLACT), m:

t=	0.0000E+00	1.0000E+00	3.0000E+01	5.0000E+01	1.0000E+02	3.0000E+02	5.0000E+02	1.0000E+03	3.0000E+03	1.0000E+05
DMFLACT=	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00

Building indoor area factor *(FAI): 0.000E+00
FAI <= 0.0 shows calculated time-dependent value based on amount of wall area
extending into the contaminated zone. Actual values used *(FAIACT):

t=	0.0000E+00	1.0000E+00	3.0000E+01	5.0000E+01	1.0000E+02	3.0000E+02	5.0000E+02	1.0000E+03	3.0000E+03	1.0000E+05
FAIACT =	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00

* - Parameters are used only for indoor radon flux

Time Dependence of Outdoor Radon Flux [FLUXO(i,t)]

Nuclide	FLUXO(i,t) (pCi/m**2/s)									
(i) t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	3.3169E+00	3.3154E+00	3.2735E+00	3.2449E+00	3.1745E+00	2.9077E+00	2.6633E+00	2.1385E+00	8.8894E-01	2.8779E-19

Time Dependence of Indoor Radon Flux [FLUXI(i,t)]

Nuclide	FLUXI(i,t) (pCi/m**2/s)									
(i) t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	1.7484E+00	1.7476E+00	1.7255E+00	1.7105E+00	1.6733E+00	1.5327E+00	1.4039E+00	1.1273E+00	4.6858E-01	1.5202E-19

Parameters Used for Calculating Indoor and Outdoor Radon Concentration

Radon Vertical Dimension of Mixing (HMIX):	2.000E+00	(m)
Average Annual Wind Speed (WIND):	2.000E+00	(m/sec)
Building Room Height (HRM):	2.500E+00	(m)
Building Air Exchange Rate (REXG):	5.000E-01	(1/hr)

Time Dependence of Outdoor Radon Concentration [CRNO(i,t)]

Nuclide		CRNO(i,t) (pCi/m**3)									
(i)	t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		2.9317E+01	2.9304E+01	2.8934E+01	2.8681E+01	2.8058E+01	2.5700E+01	2.3540E+01	1.8902E+01	7.8571E+00	2.5437E-18

Time Dependence of Indoor Radon Concentration [HCONC(i,r)]

Nuclide		HCONC(i,t) (pCi/m**3)									
(i)	t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		4.9893E+03	4.9871E+03	4.9241E+03	4.8810E+03	4.7751E+03	4.3738E+03	4.0062E+03	3.2168E+03	1.3372E+03	4.3380E-16

Outdoor Working Levels of Radon [WLOTD(i,t)]

Nuclide		WLOTD(i,t) (WL)									
(i)	t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		1.0012E-06	1.0007E-06	9.8807E-07	9.7943E-07	9.5818E-07	8.7765E-07	8.0389E-07	6.4549E-07	2.6832E-07	8.6866E-26

Indoor Working Levels of Radon [WLIND(i,t)]

Nuclide		WLIND(i,t) (WL)									
(i)	t=	0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226		3.4405E-02	3.4389E-02	3.3955E-02	3.3658E-02	3.2927E-02	3.0160E-02	2.7625E-02	2.2182E-02	9.2205E-03	2.9913E-21

Fraction of Time Spent Outdoors (FOTD): 1.101E-01
Fraction of Time Spent Indoors (FIND): 6.571E-01

Dose/Source Ratios for Radon Pathway (p=9)
Subpathway: Outdoor and Indoor Radon Flux
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,9,t) - DSRRNW(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	1.000E+05
Ra-226	Ra-226	1.000E+00	8.730E+00	8.727E+00	8.616E+00	8.541E+00	8.355E+00	7.653E+00	7.010E+00	5.629E+00	2.340E+00	7.591E-19
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	∑DSR(j)		8.730E+00	8.727E+00	8.616E+00	8.541E+00	8.355E+00	7.653E+00	7.010E+00	5.629E+00	2.340E+00	7.591E-19

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

Dose/Source Ratios for Radon Pathway (p=9)
Subpathway: Indoor Radon from Water Usage
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSRRNW(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+01	5.000E+01	1.000E+02	3.000E+02	5.000E+02	1.000E+03	3.000E+03	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	∑DSR(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

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

(A) subsection (ggg)(8) of this section; or

(B) the effluent concentrations in Table II, Column 2 of subsection (ggg)(2)(F) of this section, with the units changed from microcuries per milliliter to microcuries per gram, for radionuclides not specified in subsection (ggg)(8) of this section or paragraph (4) of this subsection.

(3) Where combinations of radionuclides are involved, the sum of the ratios between the concentrations present and the limits specified in paragraph (2) of this subsection shall not exceed one.

(4) Notwithstanding the limits specified in paragraph (2) of this subsection, no licensee shall cause the concentration of radium-226 or radium-228 in soil in unrestricted areas, averaged over any 100 square meters (m^2), to exceed the background level by more than:

(A) 5 picocuries per gram (pCi/g) (0.185 becquerel per gram (Bq/g)), averaged over the first 15 cm of soil below the surface; and

(B) 15 pCi/g (0.555 Bq/g), averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(5) No licensee shall possess, receive, use, or transfer radioactive material in such a manner as to cause contamination of vegetation in unrestricted areas to exceed 5 pCi/g (0.185 Bq/g), based on dry weight, for radium-226 or radium-228.

(6) Notwithstanding the limits specified in paragraph (2) of this subsection, no licensee shall cause the concentration of natural uranium with no daughters present, based on dry weight and averaged over any 100 m^2 of area, to exceed the following limits:

(A) 30 pCi/g (1.11 Bq/g), averaged over the top 15 cm of soil below the surface; and

(B) 150 pCi/g (5.55 Bq/g), average concentration at depths greater than 15 centimeters below the surface so that no individual member of the public will receive an effective dose equivalent in excess of 100 mrem (1 mSv) per year.

(fff) Exemption of specific wastes.

(1) A licensee may discard the following licensed material without regard to its radioactivity:

(A) 0.05 microcurie (μCi) (1.85 kilobecquerels (kBq)), or less, of hydrogen-3, carbon-14, or iodine-125 per gram of medium used for liquid scintillation counting or *in vitro* clinical or *in vitro* laboratory testing; and

(B) 0.05 μCi (1.85 kBq), or less, of hydrogen-3, carbon-14, or iodine-125, per gram of animal tissue, averaged over the weight of the entire animal.

(2) A licensee shall not discard tissue in accordance with paragraph (1)(B) of this subsection in a manner that would permit its use either as food for humans or as animal feed.

(3) The licensee shall maintain records in accordance with subsection (tt) of this section.

(4) Any licensee may, upon agency approval of procedures required in paragraph (6) of this subsection, discard licensed material included in subsection (ggg)(7) of this section, provided that it does not exceed the concentration and total curie limits contained therein, in a Type I municipal solid waste site as defined in the Municipal Solid Waste Regulations of the authorized regulatory agency (31 Texas Administrative Code Chapter 330), unless such licensed material also contains hazardous waste, as defined in Section 3(15) of the Solid Waste Disposal Act, Health and Safety Code, Chapter 361. Any licensed material included in subsection (ggg)(7) of this section and which is a hazardous waste as defined in the Solid Waste Disposal Act may be discarded at a facility authorized to manage hazardous waste by the authorized regulatory agency.

(5) Each licensee who discards material described in paragraphs (1) or (4) of this subsection shall:

(A) make surveys adequate to assure that the limits of paragraphs (1) or (4) of this subsection are not exceeded; and

(B) remove or otherwise obliterate or obscure all labels, tags, or other markings that would indicate that the material or its contents is radioactive.

(6) Prior to authorizations in accordance with paragraph (4) of this subsection, a licensee shall submit procedures to the agency for:

(A) the physical delivery of the material to the disposal site;

(B) surveys to be performed for compliance with paragraph (5)(A) of this subsection;

(C) maintaining secure packaging during transportation to the site; and

(D) maintaining records of any discards made under paragraph (4) of this subsection.

(7) Nothing in this section relieves the licensee of maintaining records showing the receipt, transfer, and discard of such radioactive material as specified in §289.201(d) of this title.

(8) Nothing in this section relieves the licensee from complying with other applicable federal, state, and local regulations governing any other toxic or hazardous property of these materials.

(9) Licensed material discarded under this section is exempt from the requirements of §289.252(t) of this title.

(ggg) Appendices.

(1) Protection factors for respirators. The following table contains protection factors for respirators[a]:

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