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Here's the third document. Lynn

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DESCRIPTION: TRANSMITTAL OF V	Y REQUEST TO ROUTINELY DISPOSE OF SLIGHTLY
CONTAMINATED SEPTIC WASTE IN A	CCORDANCE WITH 10 CFR 20.302(a)
SUMMARY: APPROVAL REQUEST	ED BY THE END OF THE FIRST QUARTER OF 1990.
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VERMONT YANKEE NUCLEAR POWER CORPORATION



Ferry Road, Brattleboro, VT 05301-7002

June 28, 1989 BVY 89-59 AFPL + 10 ENGINEERING OFFICE 580 MAIN STREET BOLTON, MA 01740 (508) 779-6711

United States Nuclear Regulatory Commission Washington, DC 20555

Attention: Document Control Desk

Reference: License No. DPR-28 (Docket No. 50-271).

Subject: Request to Routinely Dispose of Slightly Contaminated Septic Waste in Accordance with 10 CFR 20.302(a)

Dear Sir:

In accordance with the criteria of the Code of Federal Regulations, Title 10, Section 20.302(a) (10CFR20.302(a)), enclosed please find the subject application for the disposal of very low level radioactive waste materials. Vermont Yankee Nuclear Power Corporation (Vermont Yankee) hereby requests NRC approval of the proposed procedures for the disposal of slightly contaminated septic waste generated at the Vermont Yankee Nuclear Power Plant in Vermont.

This application specifically requests approval to dispose of septic tank waste, contaminated at minimal levels, which have been or might be generated through the end of station operations at the Vermont Yankee Nuclear Power Plant. The proposed method of disposal is for the on-site land spreading in designated areas in compliance with State of Vermont health code requirements for septic waste. Disposal of this waste in the manner proposed, rather than at a 10CFR Part 61 licensed facility would save Vermont Yankee not only substantial cost, but also valuable disposal site space which would then be available for wastes of higher radioactivity levels. Disposal as radioactive waste would require treatment of the biological aspects of the septage and solidification to a stable waste form, thereby increasing the volume substantially.

A radiological assessment and proposed operational controls, based upon the continued on-site disposal of septic waste as presently contained in the plant's septic tanks, are detailed in Attachments 1 and 2. Based upon this analysis, Vermont Yankee requests approval to dispose of septic tank waste on-site by land spreading in such a manner that the radioactivity concentration limit in any batch of septage to be spread does not exceed one-tenth of the MPC values listed in 10CFR 20, Appendix B, Table II; and the combined radiological impact for all disposal operations shall be limited to a total body or organ dose of a maximally exposed member of the public of less than one mrem/year (less than 5 mrem/year to an inadvertent intruder).

United States Nuclear Regulatory Commission June 28, 1989 Page 2

Due to our expected need to utilize the proposed methodology of land application of septic waste on-site during the spring of 1990, we request your review and approval of this proposed disposal method by the end of the first quarter of 1990.

We trust that the information contained in the submittal is sufficient; however, should you have any questions or require further information concerning this matter, please contact this office

Very truly yours,

VERMONT YANKEE NUCLEAR POWER CORPORATION

L Robert W. Capstick, Jr.

Licensing Engineer

MSS/emd

Enclosures

cc: USNRC - Region I USNRC - Resident Inspector, VTNPS

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ATTACHMENT 1

VERMONT YANKEE NUCLEAR POWER PLANT

APPLICATION FOR APPROVAL TO ROUTINELY DISPOSE OF SEPTIC WASTE WITH MINIMAL LEVELS OF RADIOACTIVITY

ATTACHMENT 1

VERMONT YANKEE NUCLEAR POWER PLANT

Application for Approval to Routinely Dispose of Septic Waste With Minimal Levels of Radioactivity

1.0 INTRODUCTION

Vermont Yankee Nuclear Power Corporation (Vermont Yankee) requests approval, pursuant to lOCFR20.302(a), of a method proposed herein for the routine disposal of slightly contaminated septic tank waste. Vermont Yankee proposes to dispose of this waste by spreading it on designated areas within the plant's site boundary fence. This application addresses specific information requested in lOCFR20.302(a).

2.0 WASTE STREAM DESCRIPTION

The waste involved in this application consists of residual solids and water associated with the sewage collection system at Vermont Yankee. The plant's sewage systems are of the septic tank and disposal field type. The two systems servicing the majority of the plant's sanitary waste are identified as (1) main septic system and (2) the south sewage disposal system.

The main septic system (design flow capacity 4,950 gallons/day) consists of a wastewater lift station, septic tank, and dual alternating disposal fields located on the north side of the plant. This system services the main complex of buildings central to the plant and processes approximately 3,500 gallons of wastewater per day. The septic tank, shown in Figure (1), will typically contain 9,250 gallons of septage.

The south sewage disposal system is a newly-installed (January 1989) pressurized mound system, which is used in lieu of the construction office building (COB) holding tank that had previously serviced the lavatory facilities on the south end of the plant. The new system is composed of a septic tank (5,700 gallon capacity, see Figure 2), pumping station, and pressurized mound disposal field. When dosing the field, a force main pressurizes the disposal field's piping system with the septic tank effluent, which distributes throughout the field. The south sewage disposal system has

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the design flow capacity to process 4,607 gallons of wastewater per day. The system is typically loaded at approximately 2,500 gallons per day during normal plant operations. Figure (3) indicates diagramatically the flow of both potable and wastewater throughout Vermont Yankee.

Both the main septic system and the south sewage disposal system's septic tanks collect waste from the plant's lavatories, showers, kitchens, and janitorial facilities outside the Radiological Control Area (RCA). No radioactivity is intentionally discharged to either of the septic systems. However, plant investigations into the source of low levels of contamination found in septic waste have identified that very small quantities of radioactive materials, which are below detection limits for radioactivity releases from the RCA, are carried out of the control area on individuals and accumulate in the septic waste collection tanks by way of floor wash water, showers, and hand washing. As a means of minimizing the transport of radioactivity (i.e., floor wash water) is now poured through a filter bag to remove suspended solids and dirt before the water is released into a janitorial sink.

The majority of the radioactivity found in waste sludge has been associated with the main septic tank. Grab samples of sludge from the bottom of the COB and main septic tank were analyzed by gamma spectroscopy with the following results of plant-related radionuclides:

Isotope	Activity Concentration +1 Sigma (pCi/kg Wet)	
Св-137	10.3 ± 1.8	
Co-60	45.4 ± 3.1	
Mn-54	39.3 ± 4.3	
Co-60	853.0 ± 12.0	
Zn-65	52.7 ± 8.2	
Cs-134	13.0 ± 2.2	
Cs-137	120.7 ± 5.2	
	Cs-137 Co-60 Mn-54 Co-60 Zn-65 Cs-134	

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The principle radionuclide is Cobalt-60, which accounts for 79% of the plant related activity in the septage samples. In comparison to in-plant smear samples taken for 10CFR61 waste characterizations, the septage sample from the main tank correlates very close with the distribution of radionuclides identified in-plant as shown below:

Relative Isotopic Distributions

Isotope	In-Plant Smears	<u>Main Tank Sludge</u>
Mn-54	3.6%	3.6%
Co-60	81.5	79.1
2n-65	3.8	4.9
Cs-134	0.4	1.2
Cs-137	10.3	11.2

Additional analyses of the main tank septage showed that the liquid portion of the collected sample did not contain any plant-related activation or fission products, and that essentially all of the activity in the waste was associated with the solid sludge fraction. The average density of the collected sludge was found to be approximately equal to that of water, with a wet to dry ratio of 25.4 to 1.

Both the liquid and solid fractions of the main tank septic waste were also analyzed for strontium with no detectable activity found. The liquid portion of the waste sample was also analyzed for tritium with no activity above the minimum detectable levels found. Appendix A to Attachment 2 contains the laboratory analysis reports of the samples taken from the COB and main septic tanks.

Prior to identification of the plant-related radioactivity in septage waste, the COB holding tank was being pumped on the average of twice per week, with the sludge and waste liquid transported off-site primarily to the Brattleboro, Vermont, sewage treatment facility. Waste from the main septic tank was being pumped and transported off-site for disposal on the average of twice per year.

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With the replacement of the COB holding tank by the new south sewage disposal system, and the requested implementation of on-site land disposal of accumulated septic waste, the frequency of collection tank pump-outs with land application of the waste is expected to be once per year. With the past pump-out frequency of the main tank being every six months, the accumulation of sludge at the bottom of the tank was well below its design capacity. During the 1988 sample collections, it was estimated that the sludge thickness was less than 1 foot of its 6-foot depth. However, for conservatism in the radiological evaluations, it is assumed that the sludge layer in the main septic tank and south disposal tank occupies 30% of their combined design volume, and that the frequency of pump-outs is semiannual as opposed to the expected annual cycle. Also, as noted above from laboratory analyses of the sludge layer taken from the bottom of the main tank, the average density of the tank contents is approximately equal to that of water, with a wet-to-dry ratio of 25.4 to 1. Hence, the weight of solids (W_{sol}) being disposed of is estimated, for purposes of this bounding dose assessment, to be approximately:

or, 1,400 kg of dry solids per year.

3.0 DISPOSAL METHOD

Approval of this application will allow Vermont Yankee to dispose of septage by utilization of a technique of land spreading or surface injection in a manner consistent with all applicable state of Vermont health regulations regarding disposal of septic waste. Details of the chemical and biological controls necessary to satisfy state health code requirements are provided in Reference 5.

The septage will be spread or surface injected on land areas owned by Vermont Yankee and situated within the plant's site boundary. Transportation of the septage waste to the disposal areas will involve pumping from one of the septic waste collection tanks (i.e., main septic tank, COB holding tank,

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new replacement COB septic tank, or from any other on-site septic waste collection point) into an enclosed truck-mounted tank. The enclosed tank truck is used to prevent spillage while in transit to the disposal areas. The septage will be transported to one of the two disposal sites designated for land application for septage from Vermont Yankee, and applied at a fixed rate based on either limitations imposed by the state of Vermont for heavy metals or organic content of the waste, or on the radioactivity content such that projected maximum individual doses will not exceed established dose objectives.

3.1 Septic Waste Disposal Procedure

Gamma isotopic analysis of septic waste shall be made prior to each disposal by obtaining a representative sample from each tank prior to pump-out. At least two septic waste samples will be collected from each tank to be pumped by taking a volumetric column of sludge and waste water which allows for analysis of the solid's distribution and content from top to bottom of each tank. The weight percent of solid content of the collected waste will be determined and applied to the gamma isotopic analysis in order to estimate the total radioactivity content of each tank to be pumped and spread on designated disposal fields.

These gamma isotopic analyses of the representative samples will be performed at the environmental Technical Specification lower limit of detection (LLD) requirements for liquids (see Technical Specification Table 4.9.3) in order to document the estimation of radiological impact from septage disposal.

The radionuclide concentrations and total radioactivity identified in the septage will be compared to the concentration and total curie limits established herein prior to disposal. The methodology and limits associated with determining compliance with the disposal dose and activity criteria are described in Attachment 2. If the concentration and total activity limits are met, compliance with the dose assessment criteria will have been demonstrated since the radiological analysis (Section 4.5 and Attachment 2) was based on evaluating the exposure to a maximally exposed individual and inadvertent intruder after the accumulation of twenty years of periodic semiannual

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spreading of the septic waste on a single (2 acre) plot within one of the designated disposal areas. If the activity limit per disposal area is projected to be exceeded, the appropriate exposure pathways as described in Section 4.5 will be evaluated prior to each additional application, or a separate plot within the designated disposal area will be utilized.

Annually, for years in which disposal occurs, the potential dose impact from disposal operations conducted during the year, including the impact from previous years, will be performed and results reported in the plant's Semiannual Radioactive Effluent Release Report which is filed after January 1. All exposures will be assessed utilizing the methodology described in Attachment 2.

The established dose criteria requires that all applications of septage within the approved designated disposal areas shall be limited to ensure the dose to a maximally-exposed individual be maintained less than 1 mrem/year to the whole body and any organ, and the dose to the inadvertent intruder be maintained less than 5 mrem/year. The total activity based on the measured radionuclide distribution for any single disposal plot is not expected to exceed the following:

	Maximum Accumulated Radioactivity Allowed Per Acre
Isotope	Q _i ^{lim} [µCi]
Mn-54	1.4
Co-60	120.0
Zn-65	1.4
Св-134	0,7
Cs-137	46.5

If any of the above radionuclides are projected to exceed the indicated activity values, then dose calculations will be performed prior to spreading, in accordance with the methods detailed in Section 4.2.2 of Attachment 2, to make the determination that the dose limit criteria will not be exceeded.

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The concentration of radionuclides in any tank of septic waste to be disposed of will also be limited to a combined Maximum Permissible Concentration of Water (MPC) (as listed in 10CFR, Part 20, Appendix B, Table II, Columm 2) ratio of less than or equal to 0.1.

For radiological control, each application of septage will be applied on the designated land area by approved plant procedure which adheres to the following assumptions which were used in developing the dose impact:

- During surface spreading or injection, the septage, and any precipitation falling onto or flowing onto the disposal field, shall not overflow the perimeter of the designated area.
- Septage shall not be surface spread or injected into the top 6-inch soil layer within 300 feet from any drinking water well supply.
- Septage shall not be surface spread closer than 300 feet from the nearest dwelling or public building (or within 100 feet if injected into the top 6-inch surface layer).
- Septage shall not be surface spread closer than 50 feet (or within 25 feet if injected into the top 6-inch surface layer) from any roads or site boundary adjacent to land areas.
- Septage shall not be surface spread within 100 feet (or within 50 feet if injected into the top 6-inch surface layer) of any surface water (rivers, streams, drainage ditches).
- Low areas of the approved fields, subject to seasonally high groundwater levels, are excluded from the septage application.

In addition to the radiological controls to limit the total accumulation of radioactive materials released by septic waste spreading, state of Vermont health code requirements will be followed to ensure the protection of the public and environment from chemical and biological hazards. The application rate and acreage will be determined prior to each

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disposal operation. This will vary with the chemical composition of the septage, the percent solids, and the radioactive concentrations.

3.2 Administrative Procedures

Complete records of each disposal will be maintained. These records will include the concentration of radionuclides in the septage, the total volume of septic waste disposed, the total activity in each batch as well as total accumulated on the disposal plot at time of spreading, the plot on which the septage was applied, and the results of any dose calculations required.

The annual disposal of septage on each of the approved plot areas will be limited to within the established dose, activity, and concentration criteria noted above, in addition to limitations dictated by chemical and biological conditions. Dose guidelines, and concentration and activity limits, will be maintained within the appropriate values as detailed in Attachment 2.

Any farmer using land which has been used for the disposal of septic waste will be notified of any applicable restrictions placed on the site due to the land spreading or injection of waste.

- 4.0 EVALUATION OF ENVIRONMENTAL IMPACT
- 4.1 <u>Site Characteristics</u>

4.1.1 Site Topography

The proposed disposal sites consist of two fields located on the Vermont Yankee Nuclear Power Plant site, which is located on the west bank of the Connecticut River in southwestern Vermont at latitude 42 degrees, 47 minutes north and longitude 72 degrees 31 minutes west. Both fields are on plant property within the site boundary and surrounded by a chain link fence.

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Site A contains an approximate eight-acre parcel of usable land centered approximately 2,200 feet northwest of the Reactor Building. Site B contains about two acres and is centered approximately 1,700 feet south of the Reactor Building. The usable acreage of both the north and south disposal fields is restricted to those areas which have no slopes greater than five percent to limit surface runoff. A radiological assessment based on the 1988 measured radioactivity concentrations in sludge has determined that a single two-acre plot would be sufficient for the routine disposal of septage for twenty years without exceeding the dose criteria to maximum exposed individual or inadvertent intruder. As a result, the eight-acre field to the northwest could be divided into four disposal plots, with the two-acre site at the south end of the plant site, providing a fifth plot. A portion of the United States Geological Survey topographic map (Brattleboro quadrangle), showing the plant site, is presented in the Final Safety Analysis Report (FSAR) as Figure 2.5-1. A plan map showing the plant site and the disposal sites is given on Figure 4.

The sites are located along a glacial terrace on the west side of the Connecticut River. This terrace extends about 3,000 feet west rising gently and then more abruptly to a higher terrace and then to dissected uplands. Distance to the east from the disposal sites to the river is at least 100 feet if septage is disposed of by surface spreading within the designated areas, or 50 feet if septage is injected directly into the soil.

Relief of the proposed disposal sites is low, with elevation ranging between 250 feet and 265 feet (msl). Mean water surface elevation of the adjacent river is about 220 feet.

The topographic character of the site and surrounding area is compatible with this use. The spreading of septage at these locations will have no effect on the topography of the area.

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4.1.2 Site Geology

Profiles of site exploratory borings are shown in the FSAR in Figures 2.5-8 through 2.5-11. Current site characteristics as determined from a recent detailed site investigation can be found in Reference 5.

Composition of surfacial materials is compatible with the proposed use of the site for septic waste disposal.

4.2 Area Characteristics

4.2.1 Meteorology

The site area experiences a continental-type climate with some modification due to the marine climate which prevails at the Atlantic seacoast to the east. Annual precipitation averages 43 inches and is fairly evenly distributed in each month of the year.

Potential impacts on septic waste disposal include occasional harsh weather: ice storms, severe thunderstorms, heavy rains due to hurricanes, the possibility of a tornado, and annual snowfall of from 30 to 118 inches per year. In addition, frozen ground can occur for up to 4 months of the year.

Septage spreading will be managed by written procedure such that material which is spread or a mix of that material with precipitation will not overflow the perimeter of the disposal site.

Additional information on meteorology of the site can be found in Section 2.3 of the Final Safety Analysis Report.

4.2.2 <u>Hydrology</u>

Hydrology of the site and local area is tied closely to flow in the adjacent Connecticut River. River flow is controlled by a series of hydroelectric and flood-control dams including the Vernon Dam which is about 3,500 feet downstream of the site.

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All local streams drain to the Connecticut River and the site is in the direct path of natural groundwater flow from the local watershed easterly toward the river. Site groundwater level is influenced by both precipitation and changes in the level of ponding of the Connecticut River behind the Vernon Dam due to natural flow or dam operation.

Flood flows on the Connecticut are controlled by numerous dams including five upstream of the site. Elevation of the 100-year flood is about 228 ft (ms1); and, thus, well below the elevation of the proposed site which ranges from about 250 to 265 feet (ms1). The 100-year flood level is based on information presented in References (1) and (2).

Septage disposal by means of land spreading on the proposed site will have no adverse impact on area hydrology.

Further information about site hydrology is in Section 2.4 of the FSAR.

4.3 <u>Water Usage</u>

4.3.1 Surface Water

The adjacent Connecticut River is used for hydroelectric power, for cooling water for the Vermont Yankee plant, as well as for a variety of recreational purposes such as fishing and boating. The Connecticut River is not used as a potable water supply within 50 miles downstream of the plant.

Locally, water from natural springs are used for domestic and farm purposes. FSAR Table 2.4.5 and Figure 2.4-2 show springs used within a 1-mile radius of the site. FSAR Table 2.4.4 and Figure 2.4-1 show water supplies with surface water sources which are within a ten-mile radius of the site.

There will be no impact on surface water usage or quality as a result of septage disposal due to the required separation distances between surface waters and the disposal plots.

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4.3.2 Groundwater

Based on a review of groundwater measurements in various site borings presented in the FSAR and References 3 and 5, an upper estimate of groundwater levels at the plant is about 240 feet. Considering the proximity of the Connecticut River and Vernon Pond, with a mean water surface elevation of 220 feet, this estimate for the groundwater level appears to be reasonable. Given the topography of the proposed disposal sites, it is highly unlikely that the groundwater level will be within 3 feet of the disposal area surface elevation. Prior to each application of septic waste to a disposal plot, the groundwater level in nearby test wells will be determined and no application will be allowed if the groundwater level in the vicinity of the disposal plot is found to be less than 3 feet.

Groundwater provides potable water for public wells as shown in FSAR Table 2.4.5 and Figure 2.4-1. Groundwater flow in the vicinity of the proposed disposal sites is towards the Connecticut River. There are no drinking-water wells located between the site and the river. Therefore, it is highly unlikely that any drinking water wells could be affected by septage disposal. FSAR Figure 2.4-2 and Table 2.4-5 present information on private wells near the plant.

, The Vermont Yankee on-site wells provide water for plant use. This supply is routinely monitored for radioactive contamination.

To quantify the impact of septage disposal on the Connecticut River, a conservative groundwater/radionuclide travel time analysis was performed. For an assumed average travel distance of 200 feet from the disposal site to the river, a groundwater travel time of 408 days was estimated from Darcy's Law. This estimate is based on a permeability for the glacial till of 10 gpd/ft^2 , a hydraulic gradient of 0.11 ft/ft, and a soil porosity of 0.3. This analysis conservatively assumed that the septage placed on the ground was immediately available to the groundwater. In practice, a minimum of 3 feet separation between groundwater and the surface will be required at time of application of the septic waste.

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Due to ionic adsorption of the radionuclides on solid particles in the groundwater flow regime, most radionuclides travel at only a small fraction of the groundwater velocity. For the radionuclides present in the sludge, retardation coefficients were developed from NUREG/CR-3130 (Reference 4). Retardation coefficients for Co-60, Cs-137, and Cs-134 were directly obtained from NUREG/CR-3130. The coefficients for Zn-65 and Mn-54 were conservatively estimated using NUREG/CR-3130 as a guide. The radionuclides, their half-lives, retardation coefficients, and their travel time to the river are summarized in Table 1.

TABLE 1

Radionuclide Travel Times

Radionuclide	<u>Half Life</u>	Retardation Coefficient	Travel Time <u>to River</u>
Co-60	5.3 years	860	961 years
Cs-137	30.2 years	173	193 years
.Cs-134	2.1 years	173	193 years
2n-65	244 days	3	1,224 days
Mn-54	312 days	3	1,224 days

The radiological impact on the river for the radionuclides reaching the river under this conservative analysis is discussed in Attachment 2. Water usage of the Connecticut River downstream from the disposal area is limited to drinking water for dairy cows, irrigation of vegetable crops, and irrigation of cow and cattle fodder.

Based on the assessments noted above, it is concluded that groundwater sources will not be adversely impacted as a result of septage disposal on the proposed site.

4.4 Land Use

Both the eight-acre and two-acre sites proposed for the disposal areas are currently part of the Vermont Yankee Nuclear Power Plant Site inside the plant's site boundary which is enclosed by a chain link fence. It is

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undeveloped except for transmission line structures which traverse a portion of the northern disposal area. Development potential is under the control of Vermont Yankee. At present, the eight-acre site on the north end of the plant property is used by a local farmer for the growing of feed hay for use with his dairy herd. No curtailment of this activity as a result of the low levels of radioactivity in septage will be necessary.

Utilization of the proposed sites for septic waste disposal will result in no impact on adjacent land or properties because of the separation of the disposal plots from off-site properties, the general movement of groundwater toward the river and away from adjacent land areas, and the very low levels of radioactive materials contained in the waste. Administrative controls on spreading and the monitoring of disposal area conditions will provide added assurance that this proposed practice will not impact adjacent properties.

4.5 Radiological Impact

In addition to state of Vermont limits imposed on septage spreading, based on nutrient and heavy metal content, the amount of septage applied on each of the proposed disposal plots will also be procedurally controlled to insure doses are maintained within the stated limits. These limits are based on NRC Nuclear Reactor Regulation (NRR) staff proposed guidance (described in AIF/NESP-037, August 1986). The proposed dose criteria require that the maximally exposed member of the general public receive a dose less than 1 mrem/year to the whole body or any organ due to the disposal material, and less than 5 mrem/year to an inadvertent intruder.

To assess the doses received by the maximally-exposed individual and the inadvertent intruder, six potential pathways have been identified. These include:

(a) Standing on contaminated ground,

(b) Inhalation of resuspended radioactivity,

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- (c) Ingestion of leafy vegetables,
- (d) Ingestion of stored vegetables,
- (f) Ingestion of meat, and
- (g) Ingestion of milk.

The liquid pathway was also evaluated and determined to be insignificant. Both the maximum individual and inadvertent intruder are assumed to be exposed to these pathways with difference between the two related to the occupancy time. The basic assumptions used in the radiological analyses include:

- (a) Exposure to the ground contamination and to resuspended radioactivity is for a period of 104 hours per year during Vermont Yankee active control of the disposal sites, and continuous thereafter. The 104-hour interval being representative of a farmer's time on a plot of land (4 hours per week for 6 months).
- (b) The septic tanks are emptied every 6 months. (Expected practice is to pump septic tanks once per year.)
- (c) The tank radioactivity remains constant at the currently determined level. To account for the uncertainty associated with the counting statistics, the measured activity concentrations listed in Section 2 were increased by 3 sigmas. That is, the activity concentrations employed in dose assessment and the total radioactivity content per pump-out (at 700 kg of solids per batch) are as follows:

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Isotope	Upper-Bound Activity <u>Concentration [pCi/kg_dry]</u>	Upper-Bound Activity Content [Ci/tankful]
Mn-54	1,348	9.436E-07
Co~60	23,060	1.614E-05
Zn-65	1,620	1.134E-06
Cs-134	322	2.254E-07
Cs-137	4,100	2.870E-06

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- (d) The radiation source corresponds to the accumulation of radioactive material on a single plot (two-acre) within the proposed disposal sites over a period of 20 years (40 applications at 6-month intervals). (In actuality, the proposed sites will accommodate more than one disposal plot, and, in practice, more than one plot will most probably be used with an application frequency of once per year.)
- (e) For the analysis of the radiological impact during Vermont Yankee active control of the disposal sites, all dispersed radioactive material remains on the surface and forms a source of unshielded radiation. (In practice, the septic waste will be either surface spread or directly injected within the top 6 inches of the disposal plot, in which case, the radioactive material will be mixed with the soil. This, in effect, would reduce the ground plane source of exposure by a factor of about four due to self-shielding.)
- (f) No radioactive material is dispersed directly on crops for human or animal consumption, crop contamination being only through root uptake.
- (g) The deposition on crops of resuspended radioactivity is insignificantly small.

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- (h) Pathway data and usage factors used in the analysis are the same as those used in the plant's ODCM assessment of the off-site radiological impact from routine releases, with the exception that the fraction of stored vegetables grown on the disposal plots was conservatively increased from 0.76 to 1.0 (at present no vegetable crops for direct human consumption are grown on any of the proposed disposal plots).
- (i) It is conservatively assumed that Vermont Yankee relinquishes control of the disposal sites after the fortieth pump-out (i.e., the above source term applies also for the inadvertent intruder).
- (j) For the analysis of the impact after Vermont Yankee control of the sites is relinquished, the radioactive material is plowed under and forms a uniform mix with the top six inches of soil; but, nonetheless, undergoes resuspension at the same rate as surface contamination.

From radiological impact assessments associated with the disposal of septage on different plot sizes (Attachment 2), it was determined that a single two-acre plot within the disposal sites would accommodate the l mrem/year prescribed dose to the critical organ of the maximally exposed individual for a period of up to 20 years, as well as the 5 mrem/year prescribed dose to the inadvertent intruder after control is assumed to be relinquished. The calculated potential radiation exposures following the spreading of 40 combined (main septic system and south disposal system) tankfuls (at six-month intervals) on a single two-acre plot are as follows:

Control of Disposal Sites

Controlled by VYNPS (Maximum Exposed Individual) Radiation Exposure

<u>Individual/Organ</u>

0.1 mrem/yr 0.2 mrem/yr Maximum

1.3 mrem/yr
3.9 mrem/yr Maximum

Child/Whole Body Child/Liver

Adult/Whole Body Teenager/Lung

Uncontrolled (Inadvertent Intruder)

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The individual pathway contributions to the total dose at the end of the 20-year accumulation of waste deposited on a single two-acre plot are as listed below:

Pathway-Dependent Critical Organ Doses

Pathway	Maximally Exposed Individual/Organ (Child/Liver) (mrem/year)	Inadvertent Intruder Critical Individual/Organ (Teenager/Lung) (mrem/year)
Ground Irradiation	0.0576	1.16
Inhalation	0.00122	2,74
Stored Vegetables	0.0913	0.00601
Leafy Vegetable	0.00467	0.00040
Milk Ingestion	0.0421	0.00229
Meat Ingestion	0.00249	0.00012
TOTAL	0.1994	3,909

In addition, an isotopic breakdown of the critical organ dose results listed above is shown in the following table:

Mar.	Description	Isotope	Radioactivity [µCi/2 Acres]	Exposure [mrem/yr]
	During Vermont Yankee	Mn-54	2.831	0,000436
10.60	control of the	Co~60	235.3	0.0559
	disposal sites.	Zn-65	2.801	0.0230
	Maximally Exposed	Cs-134	1.457	0.00231
	Individual/Organ:	Cs-137	92.59	0.118
No.	Child/Liver			
		TOTAL		0.199
	After Vermont Yankee	Mn-54	2.831	0.0144
	control of sites is	Co-60	235.3	3.76
	relinguished.	Zn-65	2.801	0.00983
	Inadvertent Intruder	Cs-134	1.457	0.000505
1. ara	Critical Individual/	Cs-137	92.59	0.1247
	Organ: Teenager/Lung			
		TOTAL		3.91

Isotopic Breakdown of Maximum Radiation Exposures

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Of interest are also derived dose conversion factors which provide a means of ensuring septage disposal operations within the prescribed radiological guidelines. The critical-organ (worst-case) all-pathway values per acre are as follows:

All-Pathway Critical-Organ Dose Conversion Factors During Vermont Yankee Control of Disposal Sites

Isotope	<u>Individual/Organ</u>	Exposure [mrem/yr-µCi/acre]
Mn-54	Adult/GE-LLI	3.74E-4
Co-60	Teenager/Lung	7.14E-4
Zn-65	Child/Liver	1.64E-2
Cs-134	Child/Liver	3.18E-3
Cs-137	Child/Bone	2.66E-3

The calculational methodology and details of the radiological assessment and proposed operational controls on total activity and concentration of waste to be disposed are presented in Attachment 2.

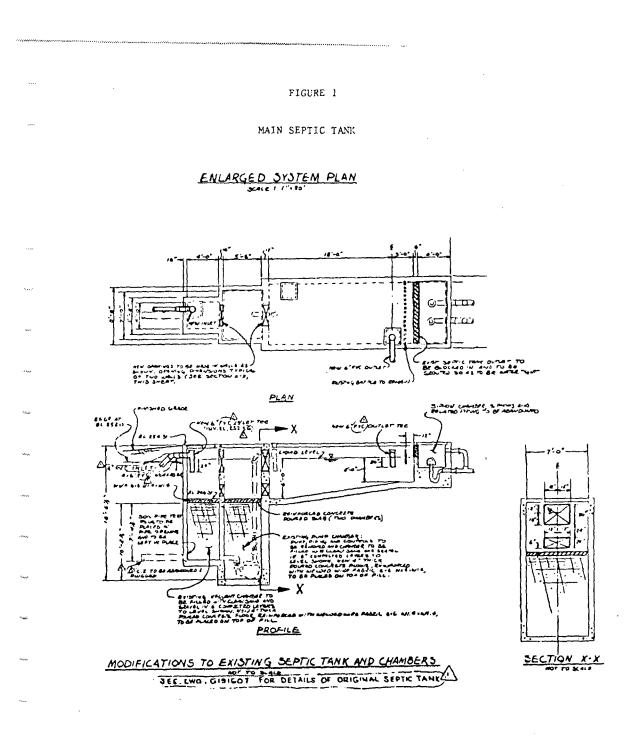
5.0 RADIATION PROTECTION

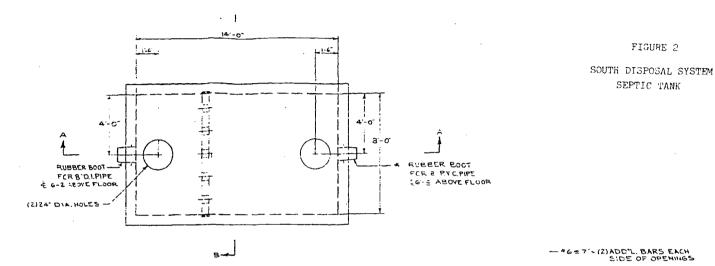
The disposal operation will follow the applicable Vermont Yankee procedures to maintain doses as low as reasonably achievable and within the specified dose and release concentration criteria.

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REF		
1.	Flood Insurance Study, Vernon, Vermont, Windham County, FEMA, Community No. 500137, July 25, 1980.	
2.	Flood Insurance Study, Town of Hinsdale, New Hampshire, Cheshire County FEMA, Community No. 330022, October 15, 1980.	
3.	Vermont Yankee Well Development Evaluation by Wagner, Heindel, and Noyes, Inc. July 10, 1986.	
4.	NUREG/CR-3130, Influence of Leach Rate and Other Parameters on Groundwater Migration, by Dames & Moore, February 1983.	
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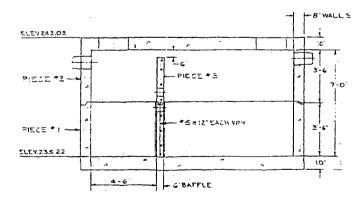




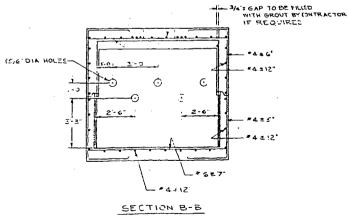
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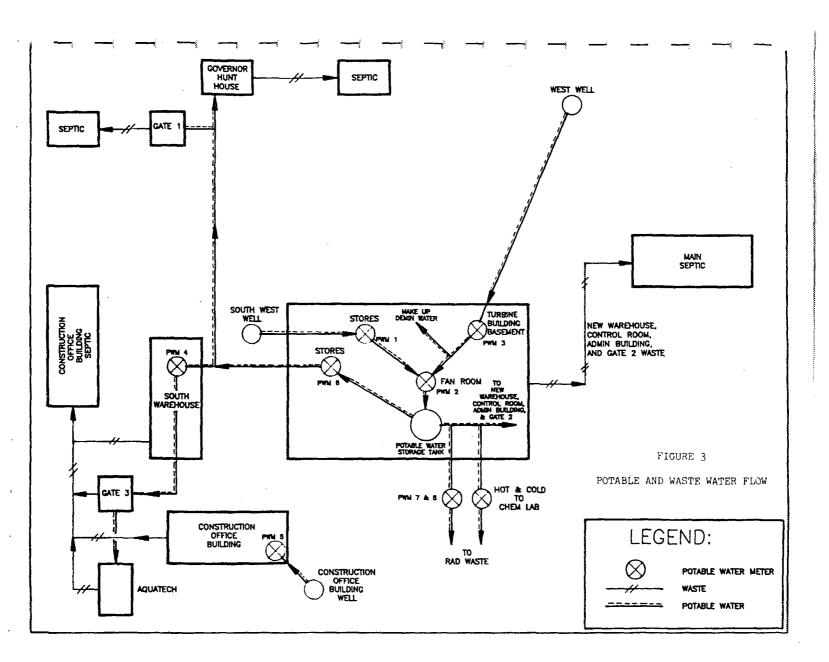
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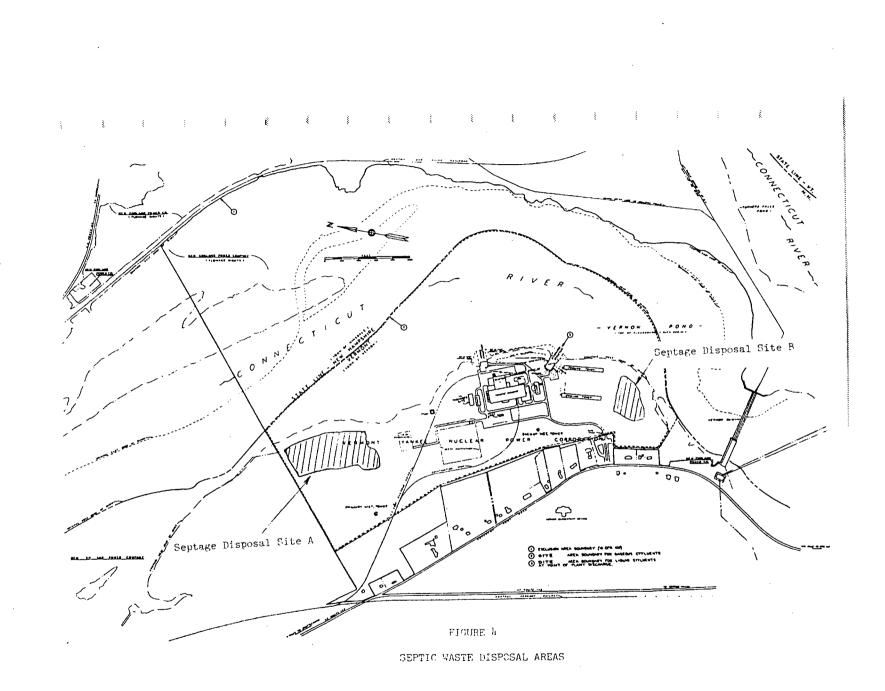




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ATTACHMENT 2

VERMONT YANKEE NUCLEAR POWER PLANT

Radiological Assessment of On-Site Disposal of Septic Waste and Proposed Procedural Controls to Ensure Compliance With Radiological Limits

1.0 INTRODUCTION

This calculation is in support of Vermont Yankee's application to the Nuclear Regulatory Commission for the on-site disposal of slightly radioactive septic waste in accordance with the provisions of 10CFR20.302 for very-low-level waste disposal. Specifically, the main purposes of the calculation were as follows:

- (a) Determination of an optimal plot size for septage disposal (based on measured 1988 radioactivity concentrations in septic waste) which would accommodate both the radiological guidelines and the needed flexibilities for a smooth operation of the disposal program.
- (b) Preparation of procedural controls to ensure compliance with the radiological guidelines.

Guidance for obtaining regulatory approval to dispose of very-low-level waste is presented in AIF/NESP-037 (Reference 6). According to this reference, the NRR staff personnel have proposed a number of draft dose guidelines regarding the impact of low-level waste disposal on the public health and safety for use in the preparation of 10CFR20.302(a) requests. Of these, the following two are pertinent to the present calculation:

> (a) Doses to the total body and any body organ of a maximally exposed individual (a member of the general public or a worker who is not

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classified as a radiation worker) from the probable pathways of exposure to the disposed material should be less than 1 mrem/yr.

(b) Doses to the total body and any body organ of an inadvertent intruder, from the probable pathways of exposure, should be less than <u>5 mrem/yr</u>.

In either case, consideration should be given to all possible exposure pathways, while allowing for land-usage restrictions which may be in effect. It is on these guidelines that the optimum disposal plot size was selected and the procedural controls prepared.

In addition to the dose guidelines listed above, the procedural controls recommended in this calculation also include MPC checks on the septage to be disposed. As stated in the above AIF report, the total activity concentration in the waste is expected to be below 50 pCi/gram (Reference (6), Page 4-1). This guideline is approximately equivalent to the MPC limits specified in 10CFR20, Appendix B, Table II, Column 2, for the release of radioactive material to unrestricted areas, and to also be approximately 50 times higher than the activities measured in the Vermont Yankee septic waste in 1988. A lower MPC ratio appears to be more appropriate for better control. As a result, and in addition to the prescribed dose limits, a combined MPC ratio of less than or equal to 0.1 was also included in the procedures to regulate the disposal of septic waste. With respect to the measured septage radioactivity, spectroscopic analyses of samples taken in 1988 from the Vermont Yankee main septic tank showed that the liquid portion of the collected samples did not contain any activation or fission products, and that the following plant-related radionuclides were found in the solids:

Isotope	Activity Concentration <u>±1 Sigma [pCi/kg dry]</u>	
Mn 54	1,126 ± 74	
Co-60	$22,400 \pm 220$	
Zn-65	$1,200 \pm 140$	
Cs-134	166 ± 52	
$C_{R} = 137$	3 824 + 92	

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2.0 SOURCE TERM AND OTHER BASIC DATA

2.1 Septic Tank Specifics

The effective capacity of the main septic tank, when filled to its maximum depth of 6 feet, is approximately 9,250 gallons. The south sewage disposal system is newly installed (January 1989) and replaces the construction office building (COB) holding tank that had previously serviced the lavatory facilities on the south end of the plant. This new system contains a 5,700 gallon septic tank. The total design capacity of both main system and new south system septic tanks is approximately 14,950 gallons.

Prior to 1988, the main tank was usually emptied every 6 months. Due to this high pump-out frequency, the accumulation of sludge at the bottom is well below the design capacity of the tank. During the 1988 sample collections, it was estimated that the sludge thickness was less than 1 foot. For conservatism in this radiological evaluation, it was assumed that the sludge occupies 30% of the design liquid volume of both the main septic tank and new south systems tank. Also, from laboratory analyses of the septic waste, the average density of the tank contents is approximately equal to that of water, and the wet to dry ratio of the sludge is 25.4 to 1. Hence, the weight of solids (W_{sol}) being disposed of is estimated for purposes of bounding dose analyses to be approximately:

w^{sol} = 14,950 gal x 3,785.4 cc/gal x 10⁻³ kg/cc x 0.30 solids fraction x (1/25.4) dry/wet ratio ≈ 700 kg

2.2 Measured and Adjusted Septic Waste Radioactivities

Gamma spectroscopic analyses of septage samples from Vermont Yankee were carried out at the Yankee Environmental Laboratory in Westborough, Massachusetts (see Appendix A). For the main septic tank, no activation or fission products were found in the liquid portion of the collected samples. In the dry solids, on the other hand, the following man-made radionuclides were found to be statistically positive at the 99.9 percent confidence level:

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Isotope	Activity Concentration <u>±1 Sigma (pCi/kg Dry)</u>			
Mn-547	1126 ± 74			
Co60	22400 ± 220			
Zn-65	1200 ± 140			
Cs-134	166 ± 52			
Cs-137	3824 <u>+</u> 92			

To account for the uncertainty associated with the counting statistics, the measured activity concentrations listed above were increased by 3 sigmas. That is, the activity concentrations employed in this calculation, and the total radioactivity content per combined tankful of both south and main septic tanks) (at approximately 700 kg of solids per batch, from Section 2.1 of this calculation) are as follows:

Isotope	Upper-Bound Activity Concentration (pCi/kg_dry)	Upper-Bound Activity Content (Ci/Batch)
Mn-54	1,348	9.436E-07
Co-60	23,060	1.614E-05
Zn-65	1,620	1.134E-06
Cs-134	322	2.254E-07
Cs-137	4,100	2.870E-06

2.3 Limiting Concentration Guidelines

The AIF Report (AIF/NESP-037) provided draft guidance on total activity concentration in waste stating that it is expected to be below 50 pCi/gram. As shown below, this guideline appears to be approximately equivalent to the MPC limits specified in 10CFR20, Appendix B, Table II, Column 2, for the release of radioactive material to unrestricted areas.

For the major radionuclides identified in the Vermont Yankee septic waste, the individual MPC limits are as follows:

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Maximum Permissible Concentrations in Water

Isotope	Soluble <u>(uCi/ml)</u>	Insoluble _uCi/ml)_
Mn-54	1.0E-4	1.0E-4
Co-60	5.0E-5	3.0E-5
Zn-65	1.0E-4	2.0E-4
Cs-134	9.0E-6	4.0E-5
Св-137	2.0E-5	4.0E-5

For a mix of radionuclides, 10CFR20 specifies that, in addition to the above individual limits, the following condition must also be met:

Σ (C_i/MPC_i) <u></u>1.0

where: C_i is the measured concentration for Isotope i, and the summation is over all radionuclides in the mix.

As indicated in Section 2.2, the 1988 spectroscopic analyses of Vermont Yankee septage samples showed that there was no radioactivity in the septic water samples. That is, the limits which are currently applicable are those listed above for insoluble compounds. Using the activity data from Section 2.2, along with the main septic tank volume of 9,250 gallons, the current upper-bound activities and MPC ratios are approximately:

	Isotope	Upper-Bound Activity <u>Content (Ci/tankful)</u>	Upper-Bound Activity Concentration (uCi/ml)	MPC Ratio
	Mn-54	9.44E-07	2.67E-08	2.67E-04
-	Co-60	1.61E-05	4.57E-07	1.52E-02
	Zn-65	1.13E-06	3.21E-08	1.60E-04
	Cs-134	2.25E-07	6.38E-09	1.59E-04
~~~	Cs-137	2.87E-06	8.13E-08	2.03E-03
	TOTAL	2.13E-05	6.03E-07	1.78E-02

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It is seen that the overall MPC ratio is approximately 1.8 % of the regulatory limit, and that the total concentration is 1.2 % of the 50 pCi/g guideline. Thus, the sludge activity concentration can be at least 50 times higher without exceeding either limit. Obviously, if the MPC ratio of 1 or the 50 pCi/g guideline are not revised, the on-site disposal of septic waste will be regulated solely by the prescribed radiation exposure limits. For better control, therefore, it is hereby proposed that, in addition to the prescribed dose limits, a combined MPC ratio of less than or equal to 0.1 be also included in the procedures to regulate the disposal of septage. Refer to Section 4 for more details.

#### 2.4 <u>Disposal Sites</u>

There are two sites on Vermont Yankee site property which are currently designated for on-site septic waste disposal, as follows:

- (a) Site A, a 8-acre site approximately 2,200 feet northwest of the Reactor Building.
- (b) Site B, a 2-acre site approximately 1,700 feet south of the Reactor Building.
- Both sites are within the plant's site boundary and surrounded by a chain link fence, and under direct control of Vermont Yankee for all access.
  - 2.5 Radioactivity at Disposal Plot After 20 Years

It is clear that, due to the longevity of the two primary isotopes identified in the sludge (Co-60 and Cs-137), the amount of radioactivity at the disposal plot will be increasing with each disposal application. However, since the content of radioactivity in septic waste is very low, and since it is neither practical nor necessary to carry out a new dose analysis prior to each disposal, the approach employed in this calculation was to assess the potential radiological impact at approximately the end of plant life. That is, the radiation source was assumed to correspond to the accumulation of

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radioactive material on a given plot within the proposed disposal sites over a period of 20 years (40 applications at an assumed 6-month interval).

Analytically, if  $Q_0$  is the amount of radioactivity per batch for a given isotope, then the total accumulated radioactivity  $Q_e$  at the disposal plot after 40 applications is given by:

$$Q_e^{\dagger} = Q_o^{\dagger} (1 + E + E^2 + E^3 + E^4 + \dots + E^{39})$$
 (2.1)

$$= Q_{0} (1 - E^{39})/(1 - E)$$
 (2.2)

(2.3)

where:  $E = \exp(-\lambda \Delta t)$ 

 $\lambda$  = is the decay constant for the selected isotope (1/year)

and

#### $\Delta t$ = time interval between applications = 0.5 year

For the isotopes of interest, the results are as follows:

				Q		Q _e
ŕ	Isotope	<u>Half Life</u>	<u>(1/yr)</u>	(Ci/batch)	۵ ⁶ ۲۵°	(Ci)
	Mn-54	312.2 d	0.8109	9.436E-7	3.000	2.831E-06
ů	Co-60	5.272 y	0.1315	1.614E-5	14.58	2.353E-04
	Zn-65	243.8 d	1.038	1.134E-6	2.470	2.801E-06
	Cs-134	2.065 y	0.3357	2.254E-7	6.464	1.457E-06
	Cs-137	30.17 y	0.02297	2.870E-6	32.26	9.259E-05

#### 2.6 Land-Spreading, Resuspension and Occupancy Factors

As pointed out above, even though the proposed sites can accommodate more than one disposal plot, only a single disposal plot will be assumed in assessing the potential radiological impact. If this plot has a surface area

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of N acres, then the surface area deposition  $S_e$  (Ci/m²) following 40 disposal applications will be equal to:

$$S_e = Q_e$$
 (Ci)/(N (acres) x 4046.9 (m²/acre)) (2.4)

The denominator of this equation is equivalent to the (D/Q) deposition factor normally employed in the impact assessment of deposited radionuclides. That is:

$$(D/Q) = 1/(N \text{ (acres) } x \text{ 4046.9 } (m^2/\text{acre}))$$
$$= 2.471E-04/N (m^{-2})$$
(2.5)

Following the application of septage on the disposal plot, some of the radioactivity may become airborne as a result of resuspension effects. The model used to estimate the radionuclide concentration in air above the disposal plot was taken from WASH-1400, Appendix VI (Reference 7). According to that model, the relationship between the airborne concentration  $A_e$  (Ci/m³) and the surface deposition is:

$$A_{p} = S_{p} (Ci/m^{2}) \times K (1/m)$$
 (2.6)

where: K is the resuspension factor and is equal to 1.0E-05 (1/m) for semi-arid/grassland terrains (from Reference 1).

In actual practice, septage waste will be either surface spread at a controlled rate per acre, or directly injected into the top 6 inch surface soil layer, at a precalculated rate, in order to control the limiting factor. The assumptions made for analytical purposes are as follows:

(a) For the analysis of the radiological impact during Vermont Yankee active control of the disposal sites, no injection will be assumed to take place; all dispersed radioactive material will be assumed to remain on the surface and to form a source of unshielded radiation.

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(b) For the analysis of the impact after Vermont Yankee control of the sites is assumed to be relinquished, the radioactive material will be assumed to be plowed under and to form a uniform mix with the top 6 inches of soil (to account for the shielding provided by the soil), but, nonetheless, to undergo resuspension at the same rate as surface contamination.

Analysis of preliminary results, based on the measured radioactivity concentration found in sludge during 1988, showed that a 2-acre disposal plot would meet the radiation criteria given in Section 2.3. This is the plot size, therefore, used in the final analyses.

As for the occupancy factors for direct exposure to the ground deposition and for immersion in the resuspended radioactivity, 104 hours were used for the radiological impact analysis during active Vermont Yankee control of the disposal sites, and continuous exposure was assumed thereafter. The 104-hour interval is expected to be an upper bound of a farmer's time spent on a plot of land, which is assumed to be 4 hours per week for 6 months while he plows, plants, and harvests his crop.

#### 2.7 Site-Specific Pathway Data and Usage Factors

The following exposure pathways were addressed in this calculation for both the maximally exposed individual (i.e., during Vermont Yankee control of the disposal sites) and for the inadvertent intruder (i.e., after control is assumed to be relinquished):

(a) Standing on contaminated ground.

(b) Inhalation of resuspended radioactivity.

(c) Ingestion of leafy vegetables.

(d) Ingestion of stored vegetables.

(f) Ingestion of meat.

(g) Ingestion of milk.

(h) Liquid pathways.

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Radiation exposures were computed for all pathways, with one exception. As shown in Section 2.8 below, the radiological impact from the liquid pathway was determined to be insignificant without the need of a detailed analysis. It should be noted that current agricultural activities permitted on the designated disposal sites are limited to the growing of feed crops (hay) for dairy animals. As such, the ingestion of leafy and stored vegetables are not existing exposure pathways, but have been included to demonstrate that these could also be accommodated within the proposed dose criteria for septic waste disposal.

Pathway data and usage factors as applicable to the area in the vicinity of the Vermont Yankee Nuclear Power Station are shown in the tables which follow. These are the same factors as used in the plant's ODCM assessment of the off-site radiological impact due to routine releases from the plant, with the following exceptions:

- (a) The soil exposure time for spreading of the radioactivity content of the septage to cover each period of measured deposition was changed from a standard 15 years (given in Regulatory Guide 1.109) to 1 year.
- (b) The fraction of stored vegetables grown on the contaminated land was conservatively increased from 0.76 to 1.0.
- (c) The crop exposure time was changed from 2160 hours to 0 hours to reflect the condition that no radioactive material will be dispersed directly on crops for human or animal consumption, the deposition on crops of resuspended radioactivity being insignificantly small; that is, crop contamination is only through root uptake.

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# USAGE FACTORS

Individual	Vegetables (kg/yr)	Leafy Veg. (kg/yr)	Milk <u>(l/yr)</u>	Meat (kg/yr)	Inhalation (m /yr)
Adult	520	64	310	110	8,000
Teen	630	42	400	65	8,000
Child	520	26	330	41	3,700
Infant		·	330		1,400

### VEGETABLE PATHWAY

	2	itored Vegetables	<u>Leafy Vegetables</u>
-000	Agricultural productivity (kg/m ² )	2.0	2.00
	Soil surface density $(kg/m^2)$	240.0	240.0
	Transport time to user (hours),	0.0	0.0
-xeer	Soil exposure time (hours)	8,766.0	8,766.0
	Crop exposure time to plume (hours)	.0	.0
	Holdup after harvest (hours)	1,440.0	24.0
	Fraction of stored vegetables grown in gar	den 1.0	
	Fraction of leafy vegetables grown in gard	len	1.0

# COW-MILK PATHWAY

Pasture Feed	Stored Feed
.7	2.0
240.0	240.0
48.0	48.0
8,766.0	8,766.0
.0	.0
.0	2,160.0
50.0	50.0
.5	
1.0	
	.7 240.0 48.0 8,766.0 .0 .0 50.0 .5

# MEAT PATHWAY

		Pasture Feed	Stored Feed
	Agricultural productivity (kg/m ² )	.7	2.0
	Agricultural productivity (kg/m ² ) Soil surface density (kg/m ² )	240.0	240.0
~~	Transport time to user (hours)	480.0	480.0
	Soil exposure time (hours)	8,766.0	8,766.0
	Crop exposure time to plume (hours)	.0	.0
94 9	Holdup after harvest (hours)	.0	2,160.0
	Animals daily feed (kg/day)	50.0	50.0
	Fraction of year on pasture	.5	
	Fraction pasture when on pasture	1.0	

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#### 2.8 Liquid Pathways

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There are three potential routes through which septic waste radioactivity may enter into the liquid pathway, as follows:

(a) Surface water runoff.

(b) Ground water pathway.

(c) Accidental releases into the Connecticut River.

Since there are no potable water wells between the disposal site and the river, it is evident that the only way for septic waste radioactivity to enter the liquid pathway is via the Connecticut River.

Even though surface water runoff may be a credible pathway into the river, the fraction of disposed radioactivity which may thus be transported to the river is very small for the following reasons:

- (1) The selected disposal sites are set back from the river.
- (2) Procedural controls will ensure that during surface spreading of all the septage and any precipitation falling onto or flowing onto the disposal plot will not overflow the perimeter of the disposal site.
- (3) The disposal plots have slopes of 5% or less in order to limit surface runoff.

With respect to septage radionuclides reaching the Connecticut River via the ground-water pathway, the critical parameter is the total transport time from the field to the river. Should this transport time (which is element dependent) be large in comparison to the half-life of the radionuclide of interest, then decay in transit will remove the said radionuclide from the pathway. For the case on hand, the conservative travel times to go an average 200 feet to the river, and the fractions of land-spread radioactivity which are expected to reach the river are as follows:

 Isotope	Half Life	Decay Constant <u>(1/yr)</u>	Travel Time to River (years) <u>(Ground Water Path)</u>	Fraction of Initial Activity Entering River
Mn-54	312.2 d	0.8109	3.35	6.61E-02
Co-60	5.272 y	0.1315	961.	0.0
 Zn-65	243.8 d	1.038	3.35	3.09E-02
Cs-134	2.065 y	0.3357	193.	0.0
Cs-137	30.17 y	0.02297	193.	1.19E-02

Thus, only small fractions of Mn-54, Zn-65, and Cs-137 may make it to the river via the ground-water pathway; and, since the initial activities of these isotopes are relatively insignificant, it is clear that the ground-water pathway is not a credible one.

We proceed, then, with the analysis of an accidental release of the entire contents of a septic waste spreading truck directly into the Connecticut River. Following such an accident, the released radioactive material is expected to first mix with part of the water in Vernon Pond and to then gradually flow downstream of the Vernon Dam. The storage volume in Vernon Pond, excluding the volume below the crest, is approximately 6.0E+9 gallons (2.3E+13 cc). Since no use is made of the river between the plant and the Vernon dam, the only potential exposure pathway is downstream of the dam; and from Reference (2), the river flow through the dam is typically 10,000 cfs, and no less than 1,200 cfs during the dry season.

As a conservative condition, assume that the septic waste mixes with just one thousandth of the Vernon pond storage volume, i.e., with 2.3E+10 cc. This amount of water will pass through the dam in about 11 minutes if the river flow is 1,200 cfs, and in about 1.3 minutes if the flow is 10,000 cfs. Using the upper-bound activities given in Section 2.3, the expected concentrations in the pond, and the corresponding MPCs are as follows:

	Isotope	Upper-Bound Activity Content (Ci/Batch)	Expected Concentration in Pond (uCi/m1)	MPC Ratio
·····	Mn-54	9.44E-07	4.10E-11	4.10E-07
	Co-60	1.61E-05	7.02E-10	2.34E-05
	Zn-65	1.13E-06	4.93E-11	2.47E-07
0000	Cs-134	2.25E-07	9.80E-12	2.45E-07
	Cs-137	2.87E-06	<u>1.25E-10</u>	<u>3.13E-06</u>
	TOTAL	2.13E-05	9.27E-10	2.74E-05

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		en that the concentra	ations are negligi	bly small to po	se any	
	radiological con					
	In summar	ry, as demonstrated a	above, the liquid	pathway is not	credible.	
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#### 3.0 RADIOLOGICAL ASSESSMENT

The radiological impact associated with the on-site disposal of radioactive septage at Vermont Yankee was carried out using the dose assessment models in Regulatory Guide 1.109, and is consistent with the methodology employed by the Vermont Yankee ODCM. However, since the computer code used (ATMODOS; Reference (3)) is primarily for use with atmospheric releases, it was necessary to manipulate the input to obtain the desired results for direct deposition of radioactivity on soil due to land spreading of septic waste. In particular, special consideration was given to the following:

- (a) The computation of an effective shielding factor to account for the effect provided by the soil after the waste is plowed under, or if it is directly injected into the top 6 inch surface layer.
- (b) The definition of an annual activity release rate, which following a year's time of continuous release, would yield the ground deposition expected to prevail after 40 combined tank pump-outs, as calculated in Section 2.5.
- (c) The definition of an effective atmospheric dispersion factor to represent the resuspended radioactivity.

(d) The proper representation of partial occupancy factors.

These are discussed in Sections 3.1 and 3.2 which follow.

The results of the radiological impact assessment are presented in Sections 3.3 and 3.4.

3.1 Dose Reduction as a Result of Plowing the Radioactive Material into the Soil

As pointed out in Section 2.6 of this calculation, the impact analysis after control of the disposal sites is relinquished, was based on the

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assumption that the radioactive material will be plowed to form a uniform mix with the top 6 inches of soil. To account for the gamma attenuation provided by the soil, it was necessary to carry out an appropriate shielding calculation. This was accomplished through use of the ALLEGRA and DIDOS-V computer codes (References 4 and 5). The ALLEGRA code was used to define the gamma spectrum (in MeV/sec) associated with the selected radionuclide mix. This spectrum was then entered into DIDOS-V to compute the radiation levels from the two following source/receptor geometries:

- (a) A circular disk source with a radius of 150 m (represented by a cylindrical volume with a height equal to 0.001 m), the receptor location being along the disk axis, 1 m from the disk.
- (b) A cylindrical volume source with a radius of 150 m and a height of 0.15 m, with the receptor located along the axis, 1 m above the source.

In the latter case, the source density was set equal to 1.6 g/cc; this is equivalent to the Reg. Guide 1.109 value of 240 kg/m² for the effective surface density of soil within a 15 cm plow layer. The source radii were assumed to be large so as to approximate semi-infinite conditions, thus, permitting a direct comparison of the DIDOS-V and ATMODOS results for the unplowed land. The source intensity (in MeV/sec-m³, as required for input into DIDOS-V) was computed by distributing the radioactive material over a 2-acre surface, and within 0.001 m for the disk source and 0.15 m for the second case.

Copies of the ALLEGRA and DIDOS-V outputs appear in Appendix B, which should be referred to for more details. The DIDOS-V results are as follows:

Dose to air from the disk source = 1.085E-06 rad/hr Dose to air from cylinder source = 2.629E-07 rad/hr Overall soil shielding factor = 2.629E-07/1.085E-06 = 0.243

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At this point, it is of interest to compare the DIDOS-V and ATMODOS exposure results from standing on contaminated ground. From the ATMODOS output in Appendix B (Section B.3.6), where the source term was the same as used in DIDOS-V, the skin dose due to exposure to contaminated ground for 104 hours is given as 6.78E-02 mrem. This is equivalent to a dose rate of 6.52E-4 mrem/hr, or (6.52E-4/1.11) = 5.87E-4 mrad/hr to air, 1.11 being the average ratio of tissue-to-air energy absorption coefficients (from Regulatory Guide 1.109). It is seen that ATMODOS underestimates the dose by a factor of 2, approximately; the reason for this is the slightly outdated set of dose conversion factors in the guide, as can be verified by inspecting the data in WASH-1400, for instance.

3.2 Data Manipulation for Use with ATMODOS

3.2.1 Radioactivity Release Rate

There are two parameters in the input to ATMODOS which affect the buildup of radioactivity at an off-site location, namely, the activity release rate and the accumulation period. To simulate this process, and to also account for the effect of the 40 applications described earlier, the accumulation period was set equal to 1 year, and the release rate was selected to be such that, at the end of one year, the total accumulated radioactivity at the disposal plot would be equal to the  $Q_e$  values given in Section 2.5. That is, if we define by  $Q_r$  the activity release rate (Ci/yr) which is required as input to ATMODOS, then the relationship between this parameter and Qe is as follows:

 $Q_{p} = Q_{r} (1 - E)/\lambda \tag{3.1}$ 

 $E = \exp(-\lambda \Delta t)$ 

(3.2)

 $\lambda$  = is the decay constant for the selected isotope (1/year) and

 $\Delta t$  = time interval between applications = 1 yr.

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Using the information given for  ${\rm Q}_{\rm e}$  in Section 2.5, the desired values for  ${\rm Q}_{\rm r}$  are as follows:

		Q _e	Q _r	Ratio of
Iso	<u>tope</u>	<u>(Ci)</u>	(Ci/yr)*	<u>(0, x 1 year)/0</u> e
Mn	54	2.831E-06	4.132E-06	1.460
Co	60	2.353E-04	2.511E-04	1.067
Zn	65	2.801E-06	4.502E-06	1.607
Cs	134	1.457E-06	1.715E-06	1.177
Cs	137	9.259E-05	9.366E-05	1.012

*For input to ATMODOS only.

3.2.2 Atmospheric Dispersion

What is of interest at this point is to provide a means of calculating the air immersion dose due to resuspension using the ATMODOS code (under the assumption that the resuspended material is due to an atmospheric release). To accomplish this, we proceed as follows. By definition, in the analysis of releases of gaseous effluents to the atmosphere, the airborne concentration at a receptor of interest is given by:

$$A_{p} = Q_{r} (Ci/yr) \times (X/Q) (sec/m^{3})/3.1536E+7 (sec/yr)$$
(3.3)

Where: (X/Q) is the atmospheric dispersion factor.

Combining Equations (2.4), (2.6) and (3.3), it is seen that, for long-lived radionuclides (where the total accumulated radioactivity at the end of one year is numerically equal to the annual release rate, i.e.  $Q_e = Q_r \times 1$  year), the airborne concentration at the disposal plot due to resuspension effects can be accommodated by the following atmospheric dispersion factor:

$$(X/Q) = K (1/m) 3.1536E+7 (sec/yr)/(N (acres) x 4046.9 (m2/acre))$$

$$= 7,792.6 (K/N) (sec/m3)$$
 (3.4)

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With K = 1.0E-5 (1/m), and N = 2 acres, the last equation reduces to:

(X/Q) = 3.896E-02 (sec/m³).

At this point it is important to note that this method of analysis is slightly conservative since the receptor is assumed to be immersed in a cloud of undecayed radioactivity. From the  $(Q_r/Q_e)$  ratios given in the last table in Section 3.2.1, it is seen that inhalation exposures will be overestimated by the following factors:

Isotope	Inhalation Exposure Overestimation Factor
Mn-54	1.460
Co-60	1.067
Zn-65	1.607
Cs-134	1.177
Cs-137	1.012

#### 3.2.3 Occupancy Factors

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As indicated in Section 2.6, the occupancy factor for exposure to ground deposition and for immersion in the resuspended radioactivity was set equal to 104 hours during control of the disposal sites, and was assumed to be continuous thereafter. Since occupancy factors cannot be entered directly into the ATMODOS code, the partial occupancy situation was accommodated as follows:

- (1) The exposure to resuspended radioactivity was handled by multiplying the effective (X/Q), as given by Equation (3.4), by (104/8760), 8,760 being the number of hours in one year; this leads to a X/Q value of 4.626E-4 sec/m³.
- (2) The exposure to radioactivity deposited on the ground was handled by setting the shielding correction factor equal to the occupancy factor (i.e., equal to 104/8760 = 0.012).

It should be noted that the (X/Q) adjustment described above is appropriate in this case since radioactive material will not be dispersed on crops for human or animal consumption. The only pathway through which crop contamination can take place is through root uptake.

#### 3.3 Land-Spreading Exposure Pathways

Three sets of ATMODOS computer runs were carried out, for the following:

- (a) Assessment of the radiological impact during Vermont Yankee control of the disposal sites.
- (b) Assessment of the radiological impact after control of the sites is assumed to be relinquished.
- (c) Development of dose conversion factors providing a correlation between pathway exposures per soil activity for each isotope of interest.

The results for each case are presented in the subsections which follow. Briefly, note that they correspond to a disposal plot size of 2 acres, which was determined to be the appropriate size to meet both the radiation exposure criteria listed in Section 2.3, and the desired flexibilities listed in Section 2.4. The whole body and critical-organ radiation exposures (after 40 pump-outs on the same plot at a concentration level equivalent to the measured 1988 concentrations in septic waste) are as follows:

	<u>Control of Disposal Sites</u>	Radiation Exposure	<u>Individual/Organ</u>
Veri	Controlled by VYNPS	0.1 mrem/yr	Child/Whole Body
	(Maximum Exposed Individual)	0.2 mrem/yr Maximum	Child/Liver
****	Uncontrolled	1.3 mrem/yr	Adult/Whole Body
	(Inadvertent Intruder)	3.9 mrem/yr Maximum	Teenager/Lung

The individual pathway contributions to the total dose are as follows:

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### Pathway-Dependent Critical Organ Doses

,	Pathway	Maximally Exposed Individual/Organ (Child/Liver) (mrem/year)	Inadvertent Intruder Critical Individual/Organ (Teenager/Lung) (mrem/year)
	Ground Irradiation	0.0576	1.16
	Inhalation	0.00122	2.74
~	Stored Vegetables	0.0913	0.00601
	Leafy Vegetable	0.00467	0.00040
	Milk Ingestion	0.0421	0.00229
	Meat Ingestion	0.00249	0,00012
	TOTAL	0.1994	3.909

In addition, an isotopic breakdown of the critical organ dose results listed above is shown in the following table:

# Isotopic Breakdown of Maximum Radiation Exposures

	Description	lsotope	Radioactivity (µCi/2 Acres)	(mrem/yr)
5	During Vermont Yankee	Mn-54	2.831	0.000436
	control of the	Co-60	235.3	0.0559
	disposal sites.	Zn-65	2.801	0.0230
·	Maximally Exposed	Cs-134	1,457	0.00231
	Individual/Organ: Child/Liver	Cs-137	92.59	0.118
•		TOTAL		0.199
	After Vermont Yankee	Mn-54	2.831	0.0144
	control of sites is	Co-60	235.3	3.76
	relinguished.	Zn-65	2.801	0.00983
	Inadvertent Intruder	Cs-134	1.457	0.000505
	Critical Individual/ Organ: Teenager/Lung	Cs-137	92.59	0.1247
	organit rechager, hang	TOTAL		3.91

As for the dose conversion factors during active plant control of the disposal sites, the critical-organ all-pathway values for a 2-acre disposal plot are:

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#### All-Pathway Worst-Case Dose Conversion Factors During Vermont Yankee Control of Disposal Sites

Isotope	<u>Individual/Organ</u>	Exposure <u>(mrem/yr-µCi)</u>
Mn-54	Adult/GE-LLI	1.87E-4
Co-60	Teenager/Lung	3.57E-4
Zn-65	Child/Liver	8.21E-3
Cs-134	Child/Liver	1.59E-3
Cs-137	Child/Bone	1.33E-3

In all cases, the exposure pathways are direct shine from shielded/unshielded ground deposition, inhalation of resuspended radioactivity, and ingestion of contaminated food (stored vegetables, leafy vegetables, milk and meat); exposure to the ground deposition and to resuspended radioactivity is for a period of 104 hours during control of the disposal sites, and continuous thereafter. Refer to Appendix B for copies of the ATMODOS outputs, and to the following list of assumptions employed in the calculations.

Briefly, the following basic assumptions were used in the calculational analyses:

(a) The septic tanks are emptied every 6 months (expected future practice is to pump tanks once per year).

(b) The tank radioactivity remains constant (at the main septic tank 1988 determined level plus 3 sigma).

(c) The radiation source corresponds to the accumulation of radioactive material on a single plot within the proposed disposal sites over a period of 20 years (40 applications at 6 month intervals). (In actuality, the proposed sites will accommodate more than one disposal plot, and, in practice, more than one plot will most probably be used.)

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(d)	For the analysis of the radiological impact during Vermont Yankee
	control of the disposal sites, no plowing or direct injection of
	septage takes place and all dispersed radioactive material remains
	on the surface and forms a source of unshielded radiation. (In
	practice, the waste will be either surface spread or directly
	injected into the top 6 inch layer of the disposed plot, in which
	case the radioactive material will be mixed with the soil. This
	in effect would reduce the ground plane source of exposure by a
	factor of about four due to self-shielding.)

- (e) No radioactive material is dispersed directly on crops for human or animal consumption, crop contamination being only through root uptake.
- (f) The deposition on crops of resuspended radioactivity is insignificantly small.
- (g) Pathway data and usage factors used in the analysis are the same as those used in the plant's ODCM assessment of the off-site radiological impact from routine releases, with the exception that the fraction of stored vegetables grown on the disposal plots was conservatively increased from 0.76 to 1.0. (At present, no vegetable crops for direct human consumption are grown on any of the disposal sites.)
- (h) It is assumed that Vermont Yankee relinquishes control of the disposal sites after the fortieth pump-out (i.e., the above source term applies also for the inadvertent intruder).
- (i) For the analysis of the impact after Vermont Yankee control of the sites is relinquished, the radioactive material is plowed under and forms a uniform mix with the top 6 inches of soil, but, nonetheless, undergoes resuspension at the same rate as surface contamination.

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(k) Exposure to the ground deposition and to resuspended radioactivity is for a period of 104 hours during Vermont Yankee control of the disposal sites, and continuous thereafter, the 104-hour interval being representative of a farmer's time on a plot of land (4 hours per week for 6 months).

#### 3.3.1 Impact During Vermont Yankee Control of the Disposal Sites

The tables which follow present summaries of the ATMODOS results for the radiological impact during Vermont Yankee control of the disposal sites. The first table presents the results for the entire mix of radionuclides, and the second table shows the contributions by each isotope.

#### Total Accumulated Radioactivity on 2-Acre Plot After 40 Disposal Applications

Isotope	Curies
Min 54	2.831E-06
Co 60	2.353E-04
Zn 65	2.801E-06
Св 134	1.457E-06
Cs 137	9.259E-05

#### Dose Delivered to Each Organ From all Radionuclides in the Mix and From All Pathways Combined* (Adult, Teenager, Child, and Infant)

(mrem/yr)

	Bone	Liver	Kidney	Lung	<u>GI-LLI</u>	Thyroid	Whole Body	Skin
А	9.20E-02	1.13E-01	7.92E-02	8.46E-02	9.66E-02	5.76E-02	9.42E-02	6.78E-02
Т	1.13E-01	1.44E-01	9.08E-02	9.90E-02	9.65E-02	5.76E-02	9.41E-02	6.78E-02
C	1.86E-01	1.99E-01	1.10E-01	9.73E-02	8.22E-02	5.76E-02	9.94E-02	6.78E-02
I	1.14E-01	1.38E-01	8.36E-02	8.08E-02	7.59E-02	5.76E-02	7.19E-02	6.78E-02

*Each pathway includes unshielded exposure to ground contamination for 104 hours, with all radioactivity assumed to be on the surface of the ground; exposure to resuspended radioactivity is also for a period of 104 hours.

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	Bone	Liver	Kidney	Lung	<u>GI-LLI</u>	Thyroid	<u>Whole Body</u>	Ski
So	ource: Mn-	-54, 2.831E	-06 Ci (2-	acre plot)	1			
	2.13E-04						2.33E-04	2.50E
Т	2.13E-04			3.34E-04			2.44E-04	2.501
С		4.36E-04					2.73E-04	2.50
I	2.13E-04	2.18E-04	2.14E-04	2.74E-04	2.15E-04	2.13E-04	2.14E-04	2.50
Sc	ource: Co-	-60, 2.353E	-04 Ci (2-	acre plot)				
A	5.20E-02	5.37E-02	5.20E-02	7.40E-02	8.32E-02	5.20E-02	5.56E-02	6.12
Т	5.20E-02	5.44E-02	5.20E-02	8.41E-02	8.30E-02	5.20E-02	5.73E-02	6.12
С	5,20E-02	5.55E-02	5.20E-02	7.80E-02	7.16E-02	5.20E-02	6.24E-02	6.12
I	5.20E-02	5.22E-02				5.20E-02	5.25E-02	6.12
Sc	urce: Zn-	-65, 2.801E	-06 Ci (2-	acre plot)				
А	3.43E-03	1.06E-02	7.13E-03	2.03E-04	6.72E-03	1.46E-04	4.87E-03	1.68
	4.61E-03		1.01E-02	2.28E-04	6.72E-03		7.38E-03	1.68
	8.72E-03	2.30E-02	1.45E-02	2.11E-04	4.16E-03		1.44E-02	1.68
Ī		2.08E-02	1.02E-02	1.88E-04	1.76E-02	1.46E-04	9.69E-03	1.68
So	urce: Cs-	134, 1.457	E-06 Ci (2	-acre plot	)			
A	5.89E-04	1.09E-03	5.06E-04	3.20E-04	2.42E-04	2.27E-04	9.31E-04	2.65
	7.92E-04			• · · · · • • ·			8.44E-04	2.65
	1.50E-03	2.31E-03			2.38E-04	2.27E-04	6.67E-04	2.65
1	7.74E-04	1.25E-03		3.35E-04	2.30E-04	2.27E-04	3.30E-04	2.65
So	urce: Cs-	137, 9.259	E-05 Ci (2	-acre plot	)			
А	3.57E-02	4.70E-02	1.93E-02	9.79E-03	5.86E-03	5.06E-03	3.25E-02	5.90
	5.52E-02						2.83E-02	5.90
	1.23E-01	1.18E-01					2.18E-02	5.90
С		6.35E-02			5.24E-03	5.06E-03	9.20E-03	5.90

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# 3.3.2 Radiological Impact After Termination of Active Control of the Disposal Sites

The table which follows presents a summary of the ATMODOS results for the radiological impact after control of the disposal sites is assumed to be relinquished after 20 years of septic waste disposal. Tables showing the contributions by the various isotopes were not prepared as they were determined to be of little significance.

#### Total Accumulated Radioactivity on 2-Acre Plot After 40 Disposal Applications

Isotope	Curies
25 Mn-54	2.831E-06
27 Co-60	2.353E-04
30 Zn-65	2.801E-06
55 Cs-134	1.457E-06
55 Cs-137	9.259E-05

#### Dose Delivered to Each Organ From all Radionuclides in the Mix and From all Pathways Combined* (Adult, Teenager, Child, and Infant) (mrem/yr)

	Bone	<u>Liver</u>	Kidney	Lung	<u>GI-LLI</u>	Thyroid	Whole Body	Skin
A	1.25E+00	1.29E+00	1.21E+00	3.04E+00	1,29E+00	1.16E+00	1.25E+00	1.37E+00
т	1.30E+00	1.35E+00	1.23E+00	3.91E+00	1.28E+00	1.16E+00	1.24E+00	1.37E+00
С	1.40E+00	1.41E+00	1.25E+00	3.39E+00	1.22E+00	1.16E+00	1.23E+00	1.37E+00
I	1.28E+00	1.32E+00	1.21E+00	2.58E+00	1.19E+00	1.16E+00	1.19E+00	1.37E+00

*Each pathway includes continuous exposure to ground contamination (uniformly distributed within a 6-inch layer of soil)

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#### 3.3.3 Isotopic Dose Conversion Factors

The table which follows presents isotope-dependent dose conversion factors for the various age groups and organs. They were computed using the ATMODOS computer code along with all the assumptions employed in the assessment of the radiological impact during Vermont Yankee control of the disposal sites. The source terms were defined using the adjustment ratio  $(Q_r \times 1 \text{ yr})/Q_e$  given in Section 3.2.1 to obtain an accumulated radioactivity of 1 uCi for each isotope of interest at the end of one year. These conversion factors form part of one of the procedural controls described in Section 4 for ensuring that the disposed contaminated septage does not lead to radiation exposures in excess of the specified limits.

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#### Dose Conversion Factors

For Radioactive Material Spread over Two Acres

For all Pathways Combined*

(Adult, Teenager, Child, and Infant)

(mrem/yr-uCi)

	Bone	Liver	<u>Kidney</u>	Lung	<u>GI-LLI</u>	Thyroid	Whole Body	<u>Skin</u>
Sc	ource: Mn-	-54						
A	7.54E-05	1.12E-04	8.63E-05	1.05E-04	1.87E-04	7.54E-05	8.24E-05	8.84E-
Т	7.54E-05	1.29E-04	9.15E-05	1.18E-04	1.85E-04	7.54E-05	8.61E-05	8.84E-
ĉ	7.54E-05	1.54E-04	9.74E-05	1.09E-04	1.41E-04	7.54E-05	9.63E-05	8.84E-
I	7.54E-05	7.71E-05	7.58E-05	9.68E-05	7.60E-05	7.54E-05	7.58E-05	8.84E-
<i>.</i>		(0)						
50	ource: Co-	·00						
A	2.21E-04	2.28E-04	2.21E-04	3.14E-04	3.54E-04	2.21E-04	2.36E-04	2.60E-
т	2.21E-04	2.31E-04	2.21E-04	3.57E-04	3.53E-04	2.21E-04	2.43E-04	2.60E-
С	2.21E-04	2.36E-04	2.21E-04	3.32E-04	3.04E-04	2.21E-04	2.65E-04	2.60E-
I	2.21E-04	2.22E-04	2.21E-04	2.92E-04	2.24E-04	2.21E-04	2.23E-04	2.60E-
So	urce: Zn-	65						
Α	1.22E-03	3.78E-03	2.55E-03	7.24E-05	2.40E-03	5.20E-05	1.74E-03	5.98E-
т	1.65E-03	5.59E-03	3.60E-03	8.12E-05	2.40E-03	5.20E-05	2.64E-03	5.98E-
С	3.11E-03	8.21E-03	5.19E-03	7.55E-05	1.48E-03	5.20E-05	5.12E-03	5.98E-
I	2.21E-03	7.44E-03	3.63E-03	6.72E-05	6.29E-03	5.20E-05	3.46E-03	5.98E-
So	urce: Cs-	134						
A	4.04E-04	7.46E-04	3.47E-04	2.19E-04	1.66E-04	1.56E-04	6.39E-04	1.82E-
т	5.44E-04	1.07E-03	4.46E-04	2.67E-04	1.67E-04	1.56E-04	5.79E-04	1.82E-
С	1.03E-03	1.59E-03	6.00E-04	3.15E-04	1.64E-04	1.56E-04	4.58E-04	1.82E-
I	5.31E-04	8.55E-04	3.36E-04	2.30E-04	1.58E-04	1.56E-04	2.26E-04	1.82E-
So	urce: Cs-	137						
A	3.86E-04	5.07E-04	2.09E-04	1.06E-04	6.33E-05	5.46E-05	3.52E-04	6.37E-
Т	5.97E-04	7.75E-04	3.00E-04	1.50E-04	6.48E-05	5.46E-05	3.06E-04	6.37E-
С	1.33E-03	1.28E-03	4.53E-04	1.98E-04	6.23E-05	5.46E-05	2.35E-04	6.37E-
I	5.94E-04	6.86E-04	2.24E-04	1.23E-04	5.66E-05	5.46E-05	9.94E-05	6.37E-

*Each pathway includes unshielded exposure to ground contamination for 104 hours, with all radioactivity assumed to be on the surface of the ground; exposure to resuspended radioactivity is also for a period of 104 hours.

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# 4.0 <u>RECOMMENDED PROCEDURAL CONTROLS TO ENSURE COMPLIANCE WITH RADIOLOGICAL</u> LIMITS

Once an on-site septage disposal permit has been secured, implementation of the disposal program must be accompanied with procedural controls to ensure that the applicable radiological limits are not violated. This section presents a list of proposed controls to this effect.

### 4.1 Total Radioactivity Dispersed per Disposal Plot

As pointed out in Section 2.5, since the content of radioactivity in septic waste is very low, and since it is neither practical nor necessary to carry out a new analysis prior to each disposal, assessment of the radiological impact was based on an assumed source corresponding to the expected accumulation of radioactive material on a given 2-acre disposal plot over a period of 20 years (40 applications at 6-month intervals). As such, it will be necessary to keep accurate records of the time and location of septage disposal and of the ensuing buildup and decay of radioactivity on each disposal plot. The basic equation to be employed is as follows:

$$Q_i^{\text{tot}} = Q_i^{\text{new}} + Q_i^{\text{old}} \exp(-\lambda_i \Delta t)$$
 (4.1)

Where:  $Q_i^{tot} =$ 

total accumulated radioactivity at the selected 2-acre disposal plot after the current disposal (uCi).

 $Q_{i}^{new}$  = radioactivity added to the plot as a result of the current disposal (uCi).

Q₁^{old} = radioactivity accumulated at the selected disposal plot prior to the current disposal (uCi), as determined at the time of the previous disposal.

 $\lambda_i =$  radioactive decay constant (1/year).

∆t =

time lapse since the previous disposal on the same disposal plot (years).

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 $Q_i^{new}$  can be calculated using the following equation:  $Q_i^{new} = 14,950$  gallons x 3,785.4 cc/gallon x 1.0E-3 kg/cc x Fs (solids fraction) x  $C_i^{wet}$  (pCi/kg wet) x 1.0E-6 (uCi/pCi) = 0.0566 Fs  $C_i^{wet}$  (4.2)

Where:  $C_i^{wet}$  is the measured or estimated radionuclide concentration in the septic waste on a wet basis, and Fs is the fraction of solids in the septage per tankful. Fs was conservatively set equal to 0.3 in this calculation. 14,950 gallons equals the volume of both the main septic tank and the south disposal system collection tank.

#### 4.2 Operational Limits

The disposal operating procedures to be established should address both the activity concentration and the potential radiation exposure. Should the activity concentration be in excess of the specified limit, then the sewage mix would not be suitable for on-site disposal and would have to be processed accordingly; this situation, however, is not likely to occur. On the other hand, approaching the exposure guideline is a possibility; but this can be easily accommodated by switching to a different plot within the disposal sites. The subsections which follow present pertinent information recommended for inclusion in the operating procedures.

#### 4.2.1 Maximum Activity Concentrations

In line with the discussion presented in Section 2.3 of this calculation, the radionuclide concentrations in the septic waste must not exceed the following limits:

(a) One tenth of the MPC values listed in 10 CFR 20, Appendix B, Table II, Column 2.

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(b) An overall MPC ratio of less than or equal to 0.1.

For the major radionuclides identified in the Vermont Yankee septic waste, the individual MPC limits are as follows:

#### Maximum Permissible Concentrations in Water (10CFR20, Appendix B, Table II)

Isotope	Soluble <u>(µCi/ml)</u>	Insoluble <u>(µCi/ml)</u>
Mn 54	1.0E-4	1.0E-4
Co 60	5.0E-5	3.0E-5
Zn 65	1.0E-4	2.0E-4
Cs 134	9.0E-6	4.0E-5
Cs 137	2.0E-5	4.0E-5

For a mix of radionuclides in the sewage mix, the condition to be met is:

Where:  $C_i$  is the measured concentration for Isotope i, and the summation is over all radionuclides in the mix.

From the 1988 spectroscopic analysis of septic waste samples, all radioactivity is expected to be in insoluble form, and no radioactivity is expected in the liquid above the sludge. Should the situation change, use should be made of both the soluble and insoluble MPCs listed above, as appropriate.

# 4.2.2 Potential Radiation Exposures

As described in Section 2.3 of this calculation, the NRR draft guidelines for radiation exposure from all probable pathways due to the disposal of low-level waste are 1 mrem/yr to the total body and any body organ of a maximally exposed individual, and 5 mrem/yr to an inadvertent intruder. The maximally exposed individual is identified as a member of the general public or a worker who is not classified as a radiation worker.

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Since the proposed septage disposal sites are within VYNPS property and under VYNPS control, occupancy of the disposal sites by an inadvertent intruder is only possible after plant decommissioning. That is, during the on-site septic waste disposal program, only the specified exposure guideline for the maximally exposed individual would be in effect.

To ensure proper operation of the on-site disposal program, a set of checkpoints was prepared as guidance. The action levels were based on the following results from Section 3:

Description	Isotope	Radioactivity (µCi/2 Acres)	Exposure (mrem/yr)
During Vermont Yankee	Mn-54	2.831	0.000436
control of the	Co-60	235.3	0.0559
disposal sites.	Zn-65	2.801	0.0230
Maximally Exposed	Cs-134	1.457	0.00231
Individual/Organ: Child/Liver	Cs-137	92.59	0,118
	TOTAL		0.199
After Vermont Yankee	Mn-54	2.831	0.0144
control of sites is	Co-60	235.3	3.76
relinguished.	Zn-65	2.801	0.00983
Inadvertent Intruder	Cs-134	1.457	0.000505
Critical Individual/ Organ: Teenager/Lung	Cs-137	92.59	0.1247
5	TOTAL		3.91

#### Isotopic Breakdown of Maximum Radiation Exposures

It is seen that, whereas the exposure to the maximally exposed individual is approximately 20% of the 1 mrem/year guideline, the inadvertent intruder exposure is almost 80% of the 5 mrem/year limit. Thus, to ensure that both guidelines are met at all times, it is intended that the <u>operational</u> guideline for the maximally-exposed individual be set at 0.2 mrem/year. This is a conservative approach since the likelihood of intruder occupancy of the sites coinciding with the end of the on-site disposal program is nil; substantial decay of the radioactive material is expected by the time the sites are released to the general public. Of course, future reassessment of this operational guideline is not precluded. However, an operational limit close to the guideline is not recommended since it eliminates all flexibilities.

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Based on the operational guideline of 0.2 mrem/yr to the maximally exposed individual, two checkpoints were prepared which would ensure that the radiation exposure limit will not be exceeded. They are as follows:

#### (a) Action Level 1 - Gross Radioactivity Limit

The up-to-date total radioactivity dispersed per disposal plot  $(Q_i^{tot})$  is calculated for each isotope using Equation (4.1). If the condition:

```
Q<sub>i</sub><sup>tot</sup> <Q<sub>i</sub><sup>lim</sup>
```

is met for each isotope, where  $\textbf{Q}_{i}^{\text{lim}}$  represents the limiting values listed in the following table (from Section 3, rounded off to 2 significant figures), then disposal of the septic waste will not violate the exposure limit; otherwise, proceed to Action Level 2.

Isotope	Maximum Accumulated Radioactivity Allowed Per Acre O. (uCi)
-	1
Mn-54	1.4
Co-60	120.0
Zn-65	1.4
Cs-134	0.7
Cs-137	46.5

(b) Action Level 2 - Radiation Exposure

If Action Level 1 fails, determine the potential radiation exposure using the equation:

Dose (mrem/yr) = 
$$\Sigma Q_i^{\text{tot}} DCF_i$$

Where:  $Q_i^{tot}$  is the up-to-date total radioactivity dispersed per disposal plot calculated for each isotope using Equation (4.1), DCF, is the dose conversion factor for isotope i, and the summation is over all the radionuclides in the mix. The dose conversion factors are as follows:

Isotope	Individual/Organ	DCF _i (mrem/year-uCi/acre)	
Mn-54	Adult/GI-LLI	3.74E-04	
Co-60	Teenager/Lung	7.14E-04	
Zn-65	Child/Liver	1.64E-02	
Cs-134	Child/Liver	3.18E-03	
Cs-137	Child/Bone	2.66E-03	

The model overestimates the exposure by approximately 20% because the above DCF's correspond to the most restrictive exposure to any individual and any organ from all pathways, independently selected for each radionuclide. The exposure pathways are direct shine from unshielded ground deposition, inhalation of resuspended radioactivity, and ingestion of contaminated food (stored vegetables, leafy vegetables, milk and meat); exposure to the ground deposition and to resuspended radioactivity is for a period of 104 (hours/year).

If the calculated dose is in excess of 0.2 (mrem/yr), a different disposal plot would have to be selected.

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5.0 <u>REFERENCES</u>

 U.S. Nuclear Regulatory Commission, <u>Reactor Safety Study</u>, Appendix VI, <u>Calculation of Reactor Accident Consequences</u>, WASH-1400 (NUREG 75/014), October 1975.

2. Vermont Yankee Nuclear Power Station, FSAR, Section 2.4.4 Uses of River.

 ATMODOS, A YAEC Computer Code for the Calculation of Off-Site Doses from Iodines and Particulates Discharged to the Atmosphere in line with the Models In Regulatory Guide 1.109

4. J. N. Hamawi, <u>ALLEGRA - A Computer Code Making Use of the ORIGEN-2 Data</u> <u>Bases for the Analysis of Radioactive Decay Chains and the Computation of</u> <u>Gamma Spectra</u>, ENTECH Engineering, Inc., Marlboro, MA, Technical Report P100-R15 (technical report in preparation).

5. J. N. Hamawi, /DIDOS-III - <u>A Three-Dimensional Point-Kernel Shielding</u> <u>Code for Cylindrical Sources</u>, ENTECH Engineering, Inc, Technical Report P100-R2, December 1982 (an upgraded version of the code, DIDOS-V, suitable for the analysis of infinitely large cylindrical sources, is currently in preparation).

6. Atomic Industrial Forum, National Environmental Studies Program, <u>A Guide</u> for Obtaining Regulatory Approval to Dispose of Very Low Level Wastes by <u>Alternative Means</u>, prepared by D. W. Chan, J. P. Davis & R. W. Wofford, General Physics Corporation, Columbia, Maryland, Technical Report No. AIF/NESP-037, August 1986.

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APPENDIX A

# LABORATORY ANALYSES OF SEPTIC WASTE

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### YANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY MAILED

#### Initial Analysis Report JUN OO IS:

Customor YAFermont Yankes Nuclear Power Corp.	Report Date: 06/09/88
Attention MSIAELABAE KEEGAN	Analysis Date: 6 /8 /88
MR. EDWARD CUMMING	Date Received: 6 /8 /88
MR. STEPHEN SKIBNIOWSKY	Reference Date: 6 /8 /88

				81udge				
Sam	ple Amount:	1.01	Kg.					Gample No.: G729
			-					ssion Code: VSL 02 23
Els	psed Time :	0.65	days				alysis	Requested: No
				Cor	nment	1		COB TANK BOTT
		DEC	λY		AC	TIV	TTY	
	NUCLIDE			COL			SIGWY	
	•	CORRE	CTION	[	P	ico	Curie	<pre>/ Kilogram - WET ]</pre>
	Np-239	8.24	E-01	(-)	.5 +-	11	) E 0	35 E O
	Co-57		E-01		5 +			
	Ce-144		E-01		-9 +-		1 E-1	
	Ce-141		E-01	·(`:	6 +-	17	j E-1	55 E-1
	Mo-99	8.49	E-01		1 +-			) 65 E O
	8e-75	9.96	E-01	· (•	-6 +-	15	j Ε-1	49 E-1
	Cr-51	9.84	E-01	Ċ	LI +-	93	j E−1	. 310 E-1
	I -131	9.45	E-01	(~)	15 +	11	) E-1	. 37 E-1
	Be-7	9.92	E-01	('10	)2 +-	94	) E-1	. 310 E-1
	Ru-103		E-01	(-:	LI +-	12	) E-1	. 38 E-1
	I -133		E-01					
	Ba-140		E-01		-			
	C6-134		E-01		16 +-	16		
	Ru-106		E~01				) E C	
*+	• •• •		E 00				) E-1	
	Ag-110M		E-01					
	Zr-95		E-01					
	Co-58		E-01	•			) E-1	
<b>.</b> .	Mn-54		E-01		-7 +-		) E-1	
*+			E 00					
	Tel-132 Fe-59		E-01		17 +- 13 +-			
	2n-65		E-01 E-01	<b>,</b> -		36		
*+	2n-65 Co-60		E-01 E 00		54 +			
*+	K -40		E 00		)7 +-			
	Sb-124		E-01		11 +-		) E-1	
Note							,	

Activity greater than 3*standard deviation Peak is found . +

### Approved by

DE My Curling D.E.McCurdy.

The quirted over-signa understainty terms do not represent the proposition of oil possible arrain anabetiand with the realizative decay present formating destication. Enclosers of the additional approach terminate constraints are the soliburium same, 2 percent, among participants leaves to detector), 2 percent, excepts non-deseptenting. 0 percent, and excepts solf-sharefilm, 2 (0 percent)

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#### MAILED VANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY

# JUH 00 16

## Initial Analysis Report

Sludge

Sample Amount:	1 02						670071
Sampre Maount:	1.02	và:	64	ample		mple No.: ion Code: VSI	G72971 03 2388
Elapsed Time :	0.63	days				equested:	None
•			Conner				K-LIQUID
NUCLIDE	DEC	АY		ACTIV			
NUCLIDE	CORRE	CTION			SIGMA	r Kilogram-wET	IDC
			((		curie /	KIIOGIAM -WEI	
Np-239	8.29	E-01	(6-	+- 10	) E O	34	EO
Co-57	9.98	E-01	( 65 4	+- 93	) E-2	310	E-2
Ce-144	9,98	E-01	(20 ⊀	+- 67	j E-1	220	E-1
Ce-141	9.87	E-01	· ( 0 +	+- 16	) E-1	52	E-1
Mo-99	8.54	E-01	(-25 +	+- 19	) E O	63	EO
Se-75	9,96	E-01	(4)	+- 14	1 E-1	48	E-1
Cr-51	9.84	E-01			Σ-1	290	
I -131	9.47	E-01			5 E-1		E-1
Be-7	9.92	E-01	(i-	+- 10	ίEΟ	35	EO
Ru~103	9,89	E-01	( 17 +	- 12	j E-1	41	E-1
I -133	6,05	E-01	(~1 +	+- 19	) E-1	65	E-1
Ba-140	9.66	E-01	(`33 +	+- 72	) E-1	240	E-1
Ce-134	9,99	E-01	(-17 -	+- 14	) E-1	48	E-1
Ru-106	9,99	E-01	(-1 -	+- 12	) E O	40	ΕO
Св~137	1.00	E 00	(-5 ⊀	+- 13	) E-1	44	E-1
Ag-110M	9,98	E-01	(-6 +	+- 16	) E-1	54	E-1
Zr~95	9.93	E-01	( 20 +	+- 22	) E-1	75	E-1
Co-58	9.94		(1) +	+- 12	) E-1	39	E-1
Mn~54	9,99	E-01	( 11 +	- 12	) E-1	39	E-1
AcTh228	1.00		(-21 +			260	E-1
<b>Tel-132</b>	8.73		( 16 +	+- 91	) E-1	300	B-1
Fe-59	9.90				) E-1		E-1
Zn-65	9.98				) E-1	110	
Co-60	1.00				) E-1	76	2-1
+ K -40	1.00		( 55 🕇				EO
Sb-124	9.93			- 34	) E-1		E-1

+ Peak is found

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Approved by

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DE IVI Carris D.E.McCurdy.

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# MAILED YANKEE ATOMIC ELECTRIC CONFANY ENVIRONMENTAL LABORATORY

# 168 0 0 St

# Initial Analysis Report

Customer 40 Vermont Yankee Nuclear Power Corp.	Report Date: 06/09/88
Attention: MSV- ELAINE KEEGAN	Analysis Date: 6 /8 /88
MR. EDWARD CUMMING	Date Received: 6 /8 /88
MR. STEPHEN SKIBNIOWSKY	Reference Date: 6 /8 /88

		Sludge
Sample Amount:	0.99 Kg.	Lab Sample No.: G72972
Elapsed Time :	0.59 days	Sample Submission Code: VSL 04 2388 Other Analysis Requested: None Comment: MAIN TANK BOTTOM
	DECAY	ACTIVITY
NUCLIDE	,	CONC. +- 1 SIGMA MDC
	CORRECTION	[ Pico Curie / Kilogram_wer ]
Np-239	8.402-01	(2 +- 21) E 0 70 E 0
Co-57	9.98E-01	(-10 +- 19 ) E-1 62 E-1
Ce-144	9.99E-01	(11 +- 14 ) E 0 45 E 0
Ce-141	9.87E-01	(-12 +- 32 ) E-1 110 E-1
Mo-99	8.6JE-01	(20 +- 38 ) E O 120 E O
Se-75	9.97E-01	(34 +- 29 ) E-1 97 E-1
Cr-51	9.852-01	$(-25 + -18) \ge 0$ 61 $\ge 0$
I -131	9.50E-01	( J +- 23 ) E-1 78 E-1
Be-7	9.92E-01	(-20 +- 19 ) E 0 65 E 0
Ru-103	9.90E-01	(-10 + 24) = -1 81 $= -1$
I -133	6.26E-01	(-25 +- J7 ) E-1 120 E-1
Ba-140	9.68E-01	(-23 +- 11 ) E 0 37 E 0
*+ C8-134	9.99E-01	(130 + 22) E - 1 48 E - 1
Ru-106	9.99E-01	$(-1 + 28) \ge 0$ 93 $\ge 0$
*+ Cs-137	1.00E 00	(1207 +- 52) E-1 130 E-1
	9.98E-01	(-8 + 53) E - 1 180 E - 1
2r-95	9.94E-01	(-77 +- 59 ) E-1 200 E-1 (-11 +- 34 ) E-1 110 E-1
Co-58	9.94E-01	
*+ Mn-54 *+ AcTh228	9.99E-01	<b>,</b> ,,
*+ AcTh228 TeI-132	.1.00E 00 8.81E-01	( 39 +- 11 ) E 0 32 E 0 (-7 +- 29 ) E 0 98 E 0
Te1-132 Fe-59	9.912-01	(-7 + 29) = -1 (68 + -73) = -1 240 = -1
*+ Zn-65	9.98E-01	(527 + 82) E-1 230 E-1
*+ Co-60	1.00E 00	(853 + 12) E 0 14 E 0
*+ K -40	1.00E 00	(223 +- 35 ) E 0 110 E 0
8b-124	9.93E-01	(-12 +- 35 ) E-1 120 E-1
Notes:		

Activity greater than 3*standard deviation
 Peak is found

Approved by

DE. M. Cu. 9 D.E. Hecurdy. ----

, we quoted an-releva uncertainty terms do not represent the properties of all parallels errors associated with the radioactics decay present fermating astellation. Solidation of the radioactics decay present fermatics are the calibration terms of the articles of the formation of the formation

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# YANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY

# MAILEU 2.51

# Initial Analysis Report

Customer :/Vermont Yankee Nuclear Power Corp. Attentions#MS!^ELATHE KEEGAN MR. EDWARD CUMMING	Report Date: 06/20/88 Analysis Date: 6 /15/88 Date Received: 6 /14/88 Reference Date: 6 /8 /88
NR. STEPHEN SKIBNIOWSKY	Reference Date: 6 /8 /88

#### Septic-Solid

		· S	eptic-Solid
Sar	mple Amount:	0.06 Kg.	Lab Sample No.: G73075 Sample Submission Code: VSLs04 2388
Ela	apsed Time :	: 7.57 days	Other Analysis Requested: None
	NUCLIDE	DECAY	Station No.: 04 Main Tank Bottom ACTIVITY CONC. +- 1 SIGMA MDC
		CORRECTION	[ Pico Curie / Kilogram ]
	Np-239	1.07E-01	(55 +- 25 ) E 2 85 E 2
	Co-57	9.81E-01	(-9 +- 30 ) E 0 99 E 0
	Ce-144	9.82E-01	(3 +- 22) E1 · 74 E1
	Ce-141	8.51E-01	(137 +- 60) E 0 190 E 0
	No-99	1.51E-01	(-60 +- 29 ) E 2 97 E 2
	Se-75	9.57E-01	(B5 +- 51) E 0 170 E 0
	Cr-51	8.27E-01	(14 +- 36) E 1 120 E 1
	I -131	5.21E-01	. (-6 +- 74 ) E O 250 E O
	8e-7	9.06E-01	(12 +- 38) E 1 130 E 1
	Ru-103	8.75E-01	(-2 +- 46 ) E 0 150 E 0
	xI -133	2.49E-03	
	Ba-140	6.64E-01	(-86 +- 40 ) E O 130 E O
*+	Cs-134	9.93E-01	(166 +- 52 ) E 0 150 E 0
	.Ru-106	9.86E-01	(12 +- 49) E 1 160 E 1
*+	Cs-137	1.00E 00	(3824 +- 92) E 0 200 E 0
	λg-110M	9.79E-01	(76 +- 96) E 0 320 E 0
	2r-95	9.22E-01	(-2 +- 11 ) E 1 36 E 1
	Co-58	9.292-01	(12 +- 60) E 0 200 E 0
*+	Mn-54	9.832-01	(1126 +- 74) E 0 200 E 0
*+	AcTh228	1.00E 00	(76 +- 17) E 1 49 E 1
	TeI-132	1.99E-01	(-14 +- 22 ) E 2 75 E 2
	Fe-59	8.90E-01	(7+-14)E1 48E1
*+	2n-65	9.79E-01	(120 +- 14) E1 40 E1
*+	Co-60	9.97E-01	(2240 +- 22) E 1 23 E 1
*+	K -40	1.00E 00	(472 +- 53) E 1 160 E 1
	Sb-124	9.17E-01	(69 +- 61 ) E 0 200 E 0
Not			
	Noticity -		dawa dawiatian

Activity greater than 3*standard deviation Peak is found Decay correction less than .01 * +

x

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Approved by

DE Mquis D.E.McCurdy.

The quoted one-signe forms include only counting statistics and do not represent the propagation of all parabble errors essectiated with the radioactive decay process. Estimates at the additional proceedie and endow uncertaining a decay califoration erver, 2 percent, ample particing, 2 percent, sample som-busegeneity. 2 10 percent, and sample self-absorption, 2 10 percent.

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# MAILEL YANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY

Attention: MS.		
MR.	STEPHEN SKIBNIOW	SKY Reference Date: 6 /8 /1
	Sept	ic-Liquid Portion
Sample Amount:	1.00 Kg.	Lab Sample No.: G7J0 Sample Submission Code: VSL104 236
Elapsed Time :	7.57 days	Other Analysis Requested: Nor
NUCLIDE	DECAY	Station No.: 04 Main Tank Botto ACTIVITY CONC. +- 1 SIGMA MDC
	CORRECTION	[ Pico Curie / Kilogram ]
Co-57	1.07E-01 9.81E-01	(142 +- 88 ) E 0 290 E 0 (-16 +- 99 ) E-2 330 E-2 (60 +- 73 ) E-1 240 E-1
Ce-141	9.82E-01 8.51E-01 1.51E-01	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$
Se-75 Cr-51	9.57E-01 8.27E-01	(-6 +- 15 ) E-1 50 E-1 ( 3 +- 11 ) E 0 36 E 0
Be-7	5.21E-01 9.06E-01	. (-6 +- 20 ) E-1 67 E-1 ( 37 +- 98 ) E-1 330 F-1
Ru-103 xI -133 Ba-140	8.75E-01 2.48E-03 6.64E-01	(-5 + -13) E-1 44 E-1 (-23 + -23) E-1 77 E-1
Cs-134 Ru-106	9.93E-01 9.86E-01	(-9 + -15) E - 1
Сs-137 Лg-110М	1.00E 00 9.79E-01	(21 +- 14) E-1 (-20 +- 18) E-1 59 E-1
2r-95 Co-58 Mn-54	9.22E-01 9.29E-01 9.83E-01	
AcTh228 Tel-132	1.006 00 1.99E-01	(28 + -61) E - 1 $(22 E - 1)(28 + -61) E - 1$ $(26 + -37) E 0$ $(20 E - 1)$
Fe-59 2n-65	8.90E-01 9.79E-01	(-1 +- 25 ) E-1 82 E-1 (31 +- 26 ) E-1 86 E-1
Co-60 + K -40	9.97E-01 1.00E 00	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$
Sb-124 Notes:	9.16E-01	(68 +- 30 ) E-1 100 E-1

Peak is found Decay correction less than .01 + x

Approved by

The queted one-signs terms include only counting statistics and do not represent the progration of all possible errors associated with the radioactive detey process. Extincts of the additional protections of radio materialistics are:	DEMaine
collbrarium curve, + 5 percent, and sample positioning, + 2 percent.	D.E.McCurdy.

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### YANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY ~-

MAILEL

# Initial Analysis Report

Customer : Vermont Yankee Nuclear Power Corp. Report Date: 07/11/88 Attention: MASHTELAINE KEEGAN Date Received: 6 /14/88 MR. EDWARD CUMMING

## Septic-Solid

····	LAB. NO. SAMPLE CODE	DATE of REFERENCE ANALYSIS	VOLUME NUCLIDE Kg	ACTIVITY CONC. +- 1 SIGMA MDC [ Pico Curie / KG - DRY '
	S73075	6 /8 7 /7	0.022 Sr-90	(-14 +- 37 )E 0 40E 0
	VSLs04 2388	Main Tank Bottom	Sr-89	(52 +- 46 )E 0 62E 0

Notes:

Int quoted one-signs terms include only counting statistics and do not represent the propagation of all possible errors associated with the radioactive decay process. Estimates of the additional systematic and random uncertainties are: calibration curve,  $\pm$  5 percent, and sample positioning,  $\pm$  2 percent. Approved by

D.E.McCurdy.

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MALED	ANKEE ATOMIC ELECTRIC COMPANY ENVIRONMENTAL LABORATORY		
	Initial Analysis Report		
Customer YALVermont Yar Attention MELS AL ELOINE MR. EDWARD	nkee Nuclear Power Corp. KEEGAN CUMMING	Report Date: Date Received:	07/11/88 6 /14/88

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		s	e	p	t	i	с	-	L	i	đ	u	i	d		р	0	r	t	i	0	n				
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~~ ~~	LAB. NO. SAMPLE CODE	DATE of REFERENCE ANALYSIS	VOLUME NUCLIDE Kg	ACTIVITY CONC. +- 1 SIGMA MDC [ Pico Curie / Kilogram ]
	S73074 VSL104 2388		1.002 Sr-90 Sr-89	( 113 +- 98 )E-2 200E-2 (-10 +- 11 )E-1 22E-1

Notes:

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re quoted one-signs terms include only counting statistics and do not represent to propagation of all possible errors associated with the radioactive decay woocess. Estimates of the additional systematic and random uncertainties are: calibration curve, <u>•</u> 5 percent, and sample positioning, <u>+</u> 2 percent.

Approved by

 $\mathcal{M}$ D.E.McCurdy. 5

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MAILED		C ELECTRIC COMPA		
		IENTAL LABORATORY		
- NUL 1 1 10	Initial	Analysis Report		
YAUC Customegressevermont Attention: MS. ELAIN MR. EDMA	(ankee Nuclear NE KEEGAN RD CUMMING	Power Corp.	Report Date: 0 Date Received: 6	7/11/88 /14/88
•	Septic-I	jquid Portion		
LAB. No. SAMPLE CODE REFE	DATE of RENCE ANALYSIS	VOLUME NUCLIDE	ACTIVITY CONC. +- 1 SIGMA [ Pico Curie / Kil	MDC ogram ]
H73074 6 VSL104 2388 Main	/8 6/20 n Tank Bottom	0.003 H-3	( 26 +- 15 )E 1	49E 1
····				
-94				
4400 -				
2000				
ning and a second s				
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1				
Notes:				
			Appr	<del>yve</del> d by •
The quoted one-signs terms include on the propagation of all possible erro process. Estimates of the additions calibration curve, • 5 percent, and	rs associated with the ra l systematic and random u	dioactive decay incertainties are:	DEMC D.E.MCC	ardy.
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#### APPENDIX B

### Computer Code Outputs

This section contains copies of the computer code outputs employed in the calculation, as follows:

B.1 ALLEGRA - Gamma Ray Spectra
B.2 DIDOS-V - Dose Reduction as a Result of Plowing
B.3 ATMODOS - Radiological Impact During VY Control of the Disposal Site

B.3.1 Impact due to Mn-54 in the Septage
B.3.2 Impact due to Co-60 in the Septage
B.3.3 Impact due to Zn-65 in the Septage
B.3.4 Impact due to Cs-134 in the Septage
B.3.5 Impact due to Cs-137 in the Septage
B.3.6 Impact due to All Nuclides in the Septage

B.4 ATMODOS - Radiological Impact After Termination of Vermont Yankee Control of the Disposal Site (All Nuclides)

B.5 ATMODOS - Unplowed-Land Dose Conversion Factors for Radiological Impact Assessment

B.5.1 Impact due to 1 uCi of Mn-54
B.5.2 Impact due to 1 uCi of Co-60
B.5.3 Impact due to 1 uCi of Zn-65
B.5.4 Impact due to 1 uCi of Cs-134
B.5.5 Impact due to 1 uCi of Cs-137

6680R

B-1

B.1 <u>ALLEGRA - Gamma Ray Spectra</u>

Richard Emch - bvy 89 59.tif

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ALLEGRA (RADIDACTIVITY 1 GANNA SPECTRA - ORIGEN-2 DATA BASE - ENTECH ENGINEERING, INC. - NOD 01 06/22/88) 88/06/30. PAGE 1

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#### TARE 4 INFUT DATA LISTING

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2	0	1 1	1	1	1	6	•	-		
3	2	1 1	0	٥						
4	1.0	1.0		0.0	0		1.	. 0	0.0	
5	MN54	250540		2.8316	-06					
á	C060	270600	:	:.3536	-04					
7	2865	300650	1	2.8010	-06					
8	CS134	351340		1.4578	-06					
7	CS137	551370	•	9.259E	-05					
10	8A137M	561371	1	8.759E	-05					

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-1

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ALLEGRA (RADIDACTIVITY & GANNA SPECTRA - ORIGEN-I DATA DASE - ENTECH ENGINEERING, INC. - NOD 01 06/22/88) 88/06/30. Page I

VY - DISPOSAL OF CONTAMINATED SEVAGE - FIELD ACTIVITY AFTER 40 TANK FUMFINGS

USER-SPECIFIED PRINTOUT CONTROL FLAGS:

NUCLIDES IN LIPRARY	:	KFRINT(1)	•	0
DECAY DATA IN LIPRARY	:	KPRINT(2)		1
GAMMA SPECTRA IN LIBRARY	:	KFRINT(3)		1
CALCULATED ACTIVITIES	:	KFRINT(4)	-	1
ISOTOPE-SPECIFIC SPECTRA	:	KFRINT(5)	-	1
TOTAL BANNA SPECTRA	:	NPRINT(6)	4	1
TAPE 11 CONTENTS	:	KERINT(7)		6
TAPE 12 CONTENTS	:	KPEINT(B)	•	0
INTERMEDIATE DECAY RESULTS	:	KFRINT(9)		2

	IBRARY SELECTION OFTION		2
INFUT	ACTIVITY UNIT CONTROL .		1
GAMMA	SFECTRA CONTROL FLAG	-	1

 JOURCE VOLUME (CURIC METERS)
 - 1.0000E+00

 JOURCE INTENSITY INPUT NULTIFLIER
 - 1.0000E+00

 NIN. ISGUTOFIC ACTIVITY FOR INCLUSION IN THE OUTFUT TARLES
 - 0.0000E+00

TOTAL NUMBER OF NUCLIDES IN THE INFUT . 6

LIST OF INPUT NUCLIDES AND ACTIVITIES (CURIES):

250540 2.8316-04 270600 2.3536-04 300650 2.8016-06 551340 1.4576-06 551370 9.2596-05 561371 8.7596-05

THERE IS CSIJ7 AND/OR RAIJ7M IN THE INFUT. Check if poth nuclides are in the infut and that the raij7m activity is 0.946 times that DF CSIJ7.

ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-2

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## ALLEGRA (RADIDACTIVITY & GANNA SPECTRA - DRIGEN-2 DATA PASE - ENTECH ENGINEERING, INC. - KOD OI 06/22/88) 88/06/30, FAGE 3 VY - DISFOSAL OF CONTANINATED SEWAGE - FIELD ACTIVITY AFTER 40 TANK FUNFINGS '

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DECAY CONSTANTS (1/HR), FRANCHING FRACTIONS AND DAUGHTER PRODUCTS - TAPE 10 PREPARATION DATE: 88/06/22.

NUCLIDE	DECAY CONST	RETA-GRND	RETA-META	FOSI-GRND	FOSI-HETA	ISONER.TR	ALFHA EN.	RETAINTER	SFONT.FIS
MN 54	9.241962-03	.000E+00	.000E+00	1.000E+00 CR 54	.000E+00	.000E+00	.0002+00	.000€+00	.0002+00
CO 60	1.500506-05	1.000E+00 81 60	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
ZN 65	1.184306-04	.000E+00	.000E+00	1.000E+00	.000E+00	.000E+00	.000E+00	.0001+00	. 000E + 00
C3134	3,834846-03	1.000E+00	.000E+00	CU 65 .000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
C5137	1.63582E-06	BA134 5.400E-02	9.460E-01 8A137M	.000€+00	.000E+00	.3006+00	.000E+00	.000E+00	.000€+00
BA1374	1.62967E+01	RA137 .000E+00	.000E+00	.000E+00	.000E+00	1.000E+00 84137	.000E+00	.000£+00	.000E+00

TOTAL NUMBER OF RADIONUCLIDES IN THE DATA LIBRARY + 1030

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## ALLEGRA (RADIOACTIVITY I GAMMA SPECTRA - ORIGEN-2 DATA DASE - CHTECH ENGINEERING, INC. - NOU 01 06/22/881 88/06/30. FAGE 4

UY - DISPOSAL OF CONTAMINATED SEVAGE - FIELD ACTIVITY AFTER 40 TANK FUMPINGS

PHOTON SPECTRA (PHOTOMS/DIS AT GIVEN ENERGY) - TAPE 10 PREPARATION DATE: 88/06/22.

NUCLIDE	.0100 HEV	.0250 MEV	.0375 HEV	.0375 HEV	.0850 HEV	.1250 HEV	.2250 HEV	.3750 HEV	.5750 MEV	
	.850 MEV	1.250 MEV	1.730 NEV	2.230 MEV	2.750 NEV	3.300 NEV	5.000 KEV	7.000 MEV	9.000 MEV	
MN 54	1.380€-01	.000E+00	.000€+00	.000E+00	. 000E +00	.000E+00	.000E+00	.000E+00-	.0005+00	
	V.820E-01	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.0005+00	
CØ 60	.000E+00	.000E+00	.000E+00	.000E+00	.000£+00	.000E+00	.000€+00	2.0306-05	.000[+00	
	7.390E-05	2.000E+00	.000E+00	1.0602-05	3.2806-08	.000E+00	.000E+00	-000E+00	.0005+00	
IN 65	3.1608-01	.000E+00	.000E+00	.0002+00	+ 000E +00	.000E+00	.000E+00	2.7508-05	2.3905-02	
	2.720E-05	4.530E-01	.000E+00	-000E+00	.000E+00	.000€+00	.000E+00	-000E+00	.000E+00	
CS134	3.970E-04	.000E+00	6.580E-03	.000E+00	.000E+00	.000E+00	2.270E-04	1-2506-04	1-2708+00	
	8.820E-01	5-830E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000£+00	.000E+00	.000£+00	
C9137	.000E+00	+000E+00	.0005+00	.000E+00	.000E+00	.000E+00	.000E+00	·000E+00	.0002+00	
	.000E+00	+000E+00	.000E+00	.000E+00	.000E+00	.000€+00	.000£+00	.000E+00	.0002+00	
BA137M	4.740E-03	.000E+00	6.0101-02	. 300E+00	.000E+00	.0002+00	.0002+00	.000E+00	1.030E+00	
	.000E+00	-000E+00	.000E+00	.000E+00	.000E+00	.000€+00	.0006+00	.000E+00	.0005+00	

TOTAL NUMBER OF GAMMA SPECTRA IN THE DATA LIBRARY - 435

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-4

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## ALLEGRA (RADIOACTIVITY : GAMMA SPECTRA - ORIGEN-2 DATA BASE - ENTECH ENGINEERING, INC. - NOD 01 06/22/80) 88/06/30. F4GE 5

VY - DISPOSAL OF CONTAMINATED SEVAGE - FIELD ACTIVITY AFTER 40 TANK PUMPINGS

RECAYED RADIDACTIVITY (CURIES) AS A FUNCTION OF DECAY TIME (HRS)

NUCLIDE	.0000E+00
NN 34	2.8310E-06
CO 60	2.3530E-04
ZN 65	2.8010E-06
C\$134	1.4570E-06
CS137	9.25902-05
84137H	8.7590E-05

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-5

# ENTECH ENGINEERING, INC. PIOI-EC3 - Page B.I-6

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TOTAL GIVEN MIX

ALL NUCLIDES ENCOUNTERED IN THE ANALYSIS

.0 % NOBLE GASES. .0 % HALOGENS. AND 100.0 % OTHERS NUCLIDE MIX CONSISTS OF

NUCLIDES WITH ACTIVITY > .000E+00 (USER-SPECIFIED LINIT)

TOTAL GIVEN MIX NOR. GASES HALOGENS OTHER T(HRS) NOR. GASES HALDGERS OTHER .000E+00 .0000E+00 .0000E+00 4.2257E-04 4.2257E-04 4.1257E-04 .0000E+00 .0000E+00 4.2257E-04 4.2257E-04 4.2257E-04

VY - DISFOSAL OF CONTAMINATED SEMAGE - FIELD ACTIVITY AFTER 40 TANK FUHFINGS RADIOACTIVITY TOTALS (CURIES) AS A FUNCTION OF DECAY TIME (HRS)

ALLEGRA (RADIDACTIVITY ; GANNA SPECTRA - DRIGEN-2 BATA PASE - ENTECH ENGINEERING, INC. - MOD 01 06/22/88) 88/06/30. FACE 6

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## ALLEGRA (RADIDACTIVITY : DAMMA SPECTRA - DRIGEN-2 DATA BASE - ENTECH ENGINEERING, INC. - (MOD DI DA/22/88) 88/06/30. FAGE 7

#### UY - DISPOSAL OF CONTAMINATED SEVAGE - FIELD ACTIVITY AFTER 40 TANK PUHFINGS

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18-GROUP	GANNA	ENERGY	RELEASE	RATES	(HEV/SE	C) AT	۲ -	.000E+00	HOU	R'S

NUCLIDE	ACTIVITY	.0100 MEV	-0250 HEV	.0375 HEV	.0575 HEV	.0850 NEV	.1250 HEV	
	(CURIES)	.225 MEV	.375 HEV	.575 HEV	.850 HEV	1.750 HEV	1.750 HEV	
		2.250 HEV	2.750 NEV	3.500 MEV	5.000 MEV	7.000 MEV	9.000 HEV	TOTAL
HN S4	2-831E-06	1.4462+02	.000E+00	.000€+00	.000E+00	.000E+00	.000E+00	
		.000E+00	.000E+00	.000E+00	B.743E+04	.000£+00	.0002+00	
		.000E+00	.000E+00	.000E+00	.000E+00	.0002+00	.0005+00	8.7586+04
CO 60	2.353E-04	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	
		.000E+00	2.2956+02	.000E+00	5.4692+02	2.1778+07	.0002+00	
		2.0762+02	7.6536-01	.000E+00	.000E+00	.000E+00	.000E+00	2.177E+07
IN 63	2.801E-06	3,2756+02	. 000E +00	.000E+00	.000E+00	.000E+00	.000E+00	
		.000E+00	1.069E+00	1.543E+03	2.3966+00	5.848£+04	.000E+00	
		.000E+00	.000E+00	.000E+00	.000£+00	.000E+00	.000E+00	6.0585404
CS134	1.4572-06	2.140E-01	.000E+00	1.330E+01	.000E+00	.000E+00	.000E+00	
		2.753E+00	2.527E+00	3.937E+04	4-0422+04	3.929E+03	.000E+00	
		.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	8.373E+04
C5137	9.259E-05	.000E+00	.000E+00	.000E+00	.000E+00	.000€+00	.000E+00	
		.000E+00	.000E+00	.000E+00	.000E+00	.0002+00	-000E+00	
		.000E+00	.000E+00	.D00E+00	. DOOE +00	.000€+00	.000E+00	.000€+00
8A137M	8.759E-05	1.5346+02	.000E+00	7.9126+03	.000E+00	.000E+00	.000E+00	
		.000E+00	.000E+00	1.919E+06	.000E+00	.000E+00	.000E+00	
		.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	1.9276+06

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ALLEGRA (RADIDACTIVITY & GANNA SPECTRA - DRIGEN-2 DATA PASE - ENTECH ENGINEERING, INC. - HOD 01 06/22/88) 88/06/30. PAGE 8

UY - DISPOSAL OF CONTAMINATED SEWAGE - FIELD ACTIVITY AFTER 40 TANK FUMFINGS

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DAMMA ENERGY RELEASE RATES (HEV/SEC) - ALL NUCLIDES OTHER THAN HOPLE GASES AND HALDGENS - (0+ 0+ 100)

AS A FUNCTION OF DECAY TINE (HOURS) - DRIGEN-2 GAMMA ENERGY GROUPS

E (MEV)	.0000E+00
.0100	4.2587E+02
.0250	.0000E+00
.0375	7.92502+03
.0575	
.0830	.0000E+00
.2250	2.7534E+00
. 3750	2.3311E+02
.5750	1.9603E+06
.8300	1.2840E+05
1.2500	2.18296+07
1.7500	.0000E+00
2.2300	2.0764E+02
2.7500	
3.5000	.0000E+00
5.0000	.0000E+00
7.0000	.0000E+00
9.0000	.0000€+00
TOTAL	2.39268+07

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-8

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# ALLEGRA (RADIDACTIVITY & GAMMA SPECTRA - DRIGEN-2 DATA DASE - ENTECH ENGINEERING, INC. - NOD 01'06/02/88) 88/06/30. PAGE 9

## UY - DISPOSAL OF CONTAMINATED SEWAGE - FIELD ACTIVITY AFTER 40 TANK FUMPINGS

#### GRAND TOTAL BAMMA ENERGY RELEASE RATES (KEV/SEC) - NOPLE GASES, HALOGENS AND DIMERS - (100.100.100)

#### AS A FUNCTION OF DECAY TIME (HOURS) - ORIGEN-2 GANNA ENERGY GROUPS

E (HEV)	.0000E+00
.0100	6.2587E+02
.0250	.0000E+00
.0375	7.92502+03
.0575	.0000E+00
.0850	.0000E+00
.1250	.0000E+00
.2250	2.7534E+00
.3750	2.3311E+02
.3750	1.9603E+06
.8500	1.28402+03
1.2500	2.1828E+07
1.7500	.0000E+00
2.2500	2.0764E+02
2.7500	7.85292-01
3.5000	.0000E+00
5.0000	.0000E+00
7.0000	.0000E+00
9.0000	.0000E+00
TOTAL	2.3926E+07

ENTECH ENGINEERING, INC. PIOI-EC3 - Page B.J-9

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-ALLEGRA (RADIDACTIVITY & GAMMA SPECTRA - ORIGEN-2 DATA BASE - ENTECH ENGINEERING, INC. - MOD 01 06/22/88) 88/06/30. PAGE 10

VY - DISFOSAL OF CONTAKINATED SEVAGE - FIELD ACTIVITY AFTER 40 TANK PUNFINGS

GAMMA ENERGY RELEASE RATES (HEV/SEC) - USER-SPECIFIED HIX - (HOR, HAL, OTHER) - ( .0, .0,100.0)

AS A FUNCTION OF RECAY TIME (MOURS) - ORIGEN-2 GAUMA ENERGY GROUPS

E (MEV)	.0000E+00
.0100	6.2587E+02
.0250	.0000E+00
.0375	7.92502+03
.0575	.0000E+00
.0850	.0000E+00
.1250	.0000E+00
.2250	2.7534E+00
.3750	2.3311E+02
. 5750	1.9603E+06
.8300	1.2840E+05
1.2300	2.1828E+07
1.7500	.0000E+00
11/300	
2.2500	2.0764E+02
2.7500	7.8529E-01
3.5000	.0000E+00
5.0000	.0000€+00
7.0000	.0000E+00
9.0000	.0000E+00
۰	
TOTAL	2.3926E+07

84866 END OF ANALYSIS \$3448

ENTECH ENGINEERING, INC. P101-EC3 - Page B.1-10

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DIRDS-V (CVLINERICAL RADIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/VANKEE ATOMIC - (NOD 01 - 10/15/66 ) 58/07/02. PAGE 1

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DIDOS-V - Dose Reduction

Result

of Plowing

#### INFUT DATA LISTING - TAFE 4

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1	VY - DISP.	. OF CONTAIL.	SEWAGE -	ACTIV.	FROH 40 FUN	FOUTS/2	ACRES - UNPLOWER	LANS
2	1 (	0 8 1	2 1	0.0	0.1236	2.0	50.0	
3	1	0.0	150.0	0.001				
4	1	0.0	100.0	0.001				
5	1.001	-1.0						

ENTECH ENGINEERING, INC. Pl01-EC3 - Page B.2-1

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#### DIDOS-V (CYLINDRICAL REDIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/YANKEE ATONIC - (NON 01 - 10/15/86 ) 86/07/02. PAGE :

#### INFUT DATA LISTING - TAPE 11

5 3 CARD : 4 ó з 1 SEQ. 12345678901234567890123456789012345678901234567890123456789012345678901234567890

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.2-2

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#### MAXIMUM PATH-LENGTH USED IN ANALYSIS (HFP) -50.0

9.795E+02 3.4238-02 .000 .000 .000 1.737E+00 2.4438-03 -038 1 .375 2-8812+01 1.2668-02 .000 .000 . 200 1.330E+00 2.4846-03 234 . 375 2.423E+05 1.0408-02 .000 .000 .000 1.241E+00 2.408E-03 1.375E-03 2.342E-03 2.347E-03 .850 1.587E+04 8.887E-03 .000 .000 . 000 1.183E+00 2.564E+06 7.355E-03 1.1378+00 5 1.250 .000 .000 .000 .000 2.250 5.3986-03 .000 .000 TOTAL

## SHIELD SLA	PS MATERIAL	DENSITY(G/CC)	THICKNESS (H)	ANGLE (PEG)	DELTA	
	AIR	1.2936-03				
** DOSE POINT	DESCRIPTION	RECEPTOR D	H AXIS	2-DINERSIONAL	AHALYSIS	
E	LEVATION RELATIVE	TO LOWER END OF SOU	RCE (HETERS) -	1-001E+00		
## RESULTS						
GAMMA Group	ENERGY ADJ. INT (NEV) (NEV/S-		NTAINER HUST DIAL - AXIAL	SHIELD OVERALL HUGT BUILDUP	INTORL VAL DOSE TO A WITH BLDUP (R/HR)	

		NONE					
r	SHIELD SLAPS	MATERIAL	DENSITY(G/CC)	THICKNESS (B)	ANGLE (PEG)	DELTA	
		AIR	1.2936-03				
ŀ	DOSE POINT DESC	RIFTION	RECEPTOR D	H AXIS	2-DINERSIONAL AND	ALYSIS	
	ELEVAT	ION RELATIVE	TO LOWER END OF SOU	RCE (HETERS) -	1.001E+00		
ĸ	RESULTS						

RECEPTOR 1 TIME (HRS) -.00

** SOURCE DESCRIPTION

**SE CONTAINER** 

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MATERIAL

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.2-3

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VY - DISF. OF CONTAM. SEVAGE - ACTIV. FROM 40 FUNFOUTS/2 ACRES - UNFLOWED LAND

DENSITY (G/CC)

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BIBOS-V (CYLINDRICAL RADIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/YANKEE ATONIC - (KOD 01 - 10/15/86 ) 88/07/02, FAGE 3

VOLUME (CUP.N.) - 7.049E+01 DENSITY (G/CC) -Mikihum Source Intensity for independent Analysis -

HAX EHERGY DIFF FOR INDEPENDENT ANALYSIS (FERCENT) -

RADIUS (H)

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AIR 1.000E-03

1.293E-03 .000E+00

1.2368-01

2.000E+00

RAD. THICKNESS (G)

1.009E-09

1.2118-11

9.941E-08 6.232E-09 9.783E-07

8.0526-12

1.0852-06

MATERIAL -Height (Keters) -

DENSITY (G/CC) -

REIGHT (1)

r

UFRIGHT CIRCULAR CYLINDER Radius (Heters) = 1.5000+02

SOURCE INTENSITY INFUT HULLIFLIEK -

#### DIDOS-V (CYLINDRICAL RADIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/YANKEE ATOHIC - (NOD 01 - 10/15/86 ) 85/07/02, PAGE 1

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#### INFUT DATA LISTING - TAPE 4

CARD 1 2 3 4 5 6 7 8 3ED. 12345678901234567890123456789012345678901234567890123456789012345678901234567890

1	VY - DISP.	OF CONT	AN. SEWAGE	- ACTIV	. FROM 40 PUMPOUTS/2 ACRES - FLOWED LAND	
:	1 0	6	1 2	1 0.0	6.237E-04 3.0 50.0	
3	3	1.6	150.0	.15		
4	3	1.6	150.0	.15		
5	1.15	-1.0				

ENTECH ENGINEERING, INC. P101-EC3 - Page B.2-4

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#### DINOS-V (CYLINDRICAL RADIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/YANKEE ATONIC - (NOD 01 - 10/15/86 ) 88/07/02. FAGE 2

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#### INFUT DATA LISTING - TAFE 11

2

CARD JEQ. 1 2 3 4 5 6 6 7 8 1234567840123456784012345678701234567890123456789012345678901234567890

1 2 3 4 VY - DISPOSAL OF CONTAMINATED SEWAGE - FIELD EQUILIBRIUM ACTIVITY (REV/SEC)

TINE (MRS) .000E+00 3.750E+02 3.750E-01 5.750E+01 8.500E-01 1.750E+00 2.250E+00 7.925E+03 2.331E+02 1.760E+06 1.284E+05 2.163E+07 2.076E+02

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ENTECH ENGINEERING, INC. P101-EC3 - Page B.2-5

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BIDDS-V (CYLINDRICAL RADIATION SOURCE DOSINETRY) - ENTECH ENGINEERING/YANKEE ATOMIC - (MOD 01 - 10/15/86 ) 86/07/07. PAGE 3

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VY - DISP. OF CONTAM. SEWAGE - ACTIV. FROM 40 FUNFOUTS/2 ACRES - FLOWED LAND

RECEPTOR 1 TIME (HRS) - .00

11 SOURCE DESCRIPT	TION	UFRIGHT CIRCULAR	CYLINDER	MATERIAL	- C1	DHCRETE
		KADIUS (NETERS)	- 1.300E+32	HEIGHT (HETERS)	- 1	.5008-01
		VOLUME (CUB.G.)	- 1-360E+04	DENSITY (G/CC)	- 1	. 600E+00
		MININUM SOURCE 1	HTENSITY FOR INDEP	ENDENT ANALYSIS	-	.000E+00
		SOURCE INTENSITY	INPUT HULTIPLIER	_	а	.237E-04
		MAX ENERGY DIFF	FOR INDEFENDENT AN	HALYSIS (PERCENT)	- 3	.0002+00
## CONTAINER	MATERIAL	DENSITY(G/CC)	RADIUS (K)	HEIGHT (N)	RA.	D. THICKNESS (
	NONE					
## SHIELD SLAPS	MATERIAL	DENSITY (G/CC)	THICKHESS (M)	ANGLE (DEG)		DELTA
	AIR	1.2938-03				
** DOSE FOINT DES	CRIFTION	RECEPTOR D	N AXIS	2-DINENSIONA	ANAL"	515

ELEVATION RELATIVE TO LOWER END OF SOURCE (HETERS) - 1.150E+00

BEEESSEE END OF FROMLEN SEESSEE

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SE RESUL	15	•							
GAM	NA EHERGY	ADJ. INTERS	SOURCE ATT	CONTAINE	R HUST	SHIELD	OVERALL	INTGRE VAL	DOSE TO AIR
GROU		(HEV/5-H3)	COEF (1/H)	RADIAL -	AXIAL	MUTT	FUILDUF	WITH BLOUP	(£/HR)
1	,039	6.528E+00	1.114E+02	.000	.000	.000	1.371E+00	6.1812-03	1.701E-11
-	.375	1.9206-01	1.5826+01	.000	. 000	.000	2.398E+00	7.577E-02	2.462E-12
ž	.575	1.6146+03	1.321E+01	.000	.000	.000	2.274E+00	7.860E-02	2.162E-08
	.850	1.0586+02	1.1020+01	.000	.000	.000	2.014E+00	8.178E-02	1.4346-09
5	1.250	1.796E+04	9.109E+00	.000	.000	. 000	1.8126400	8.6896-02	2.398E-07
4	2.250	1.710E-01	6.742E+00	.000	.000	.000	1.576E+00	9.613E-02	2.179E-12
								TOTAL	2.6298-07

MAXINUM FATH-LENGTH USED IN ANALYSIS (HFF) - 30.0

ENTECH ENGINEERING, INC. P101-EC3 - Page B.2-6

are 1	B.3 ATMODOS - Radiological Impact During VY Control of the
	Disposal Site
	Presented below is a partial listing of one of the ATMODOS Tape 5
	inputs used in this portion of the calculation. It corresponds to the
	output in Sec. B.3.6 below. With the exception of the nuclide data
ч.	library, a large portion of which was deleted due to space limitations,
	the listing is complete.
-	The Tape 5 listings corresponding to the outputs in Sec. B.3.1
	through B.3.5 are similar, except that a single isotope was analyzed in
-·	each case. Also, the tables with the detailed pathway/isotope/organ
-	exposures were excluded from the output.
· · · · · · · · · · · · · · · · · · ·	1 1VYPI VY STANDARD PROGRAM INFORMATION FILE VY - SEWAGE CONTAM - SOLIDS 1% BY WT - 2 ACRES - SHIELD F = 0.012 - 104 HR OCCUP 1200 44.56FRESH .500YESNO NO 0012 1.NO NO NO 0.1.00 EOR DOF 0 2VYGASRLGAS STK VY 87 1 1 0 87063023: MN54 4.132E-6 25 MN 54 COG0 2.511E-4 27 CO 60 ZN65 4.502E-6 30 ZN 65 CS134 1.715E-6 55 CS 134 CS137 9.366E-5 55 CS 137 EOR DOF 1 5QUERY PATHWAYS: SHORE(1,2,3), BND, ROAD, RES1, RAD, MEAT, GOAT, COW SHORE1 YESYES SHORE2 YESYES SHORE2 YESYES BOUND YESYES RES1 YESYESS RES1 YESYESSYES REAT YESYESYESYES YESYES MEAT YESYESYESYES YESYES COW YESYESYESYES YESYESYES COW YESYESYESYES YESYESYES COM YESYESYESYES YESYESYES COM YESYESYESYES YESYESYES COM YESYESYESYES YESYESYES COM YESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYESYES YESYESYES COM YESYESYESYESYES YESYESYES COM YESYESYESYESYESYESYESYESYES
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ENTECH ENGINEERING, INC. P101-EC3 - Page B.3-1

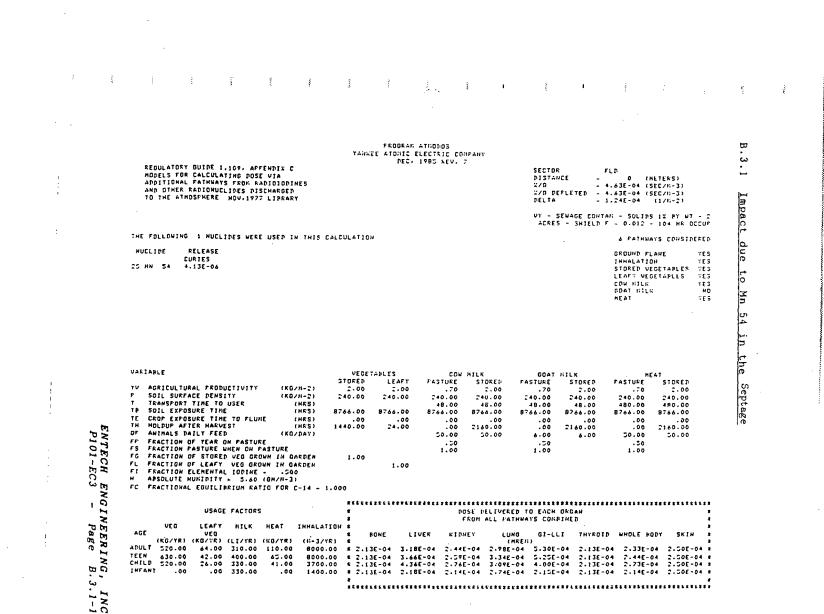
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1 6VYUFMAXVY MAXIMUM INDIVIDUAL USAGE FACTORS FOR STANDARD PFORBLENS .00 8000.00 64.00 310.00 110.00 21.00 520.00 .00 .00 12.00 630.00 42.00 400.00 65.00 16.00 .00 .00 67.00 .00 8000.00 .00 3700.00 520.00 26.00 330.00 41.00 6.90 .00 .00 14.00 .00 1400.00 .00 .00 330.00 .00 .00 .00 .00 .00 --EOR-----EOF--1 7VYGSD VY MAX INDIVIDUAL GAS SITE DATA FILE FOR STANDARD PROBLEMS .70 .70 .70 2.00 2.00 2.00 2.00 2.00 240.00 240.00 240.00 240.00 240.00 240.00 240.00 240.00 .00 .00 48.00 48.00 48.00 48.00 480.00 480.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1440.00 24.00 2160.00 .00 2160.00 2160.00 **.0**0 **.0**0 .00 .00 50.00 50.00 6.00 6.00 50.00 50.00 .50 .00 .00 .50 .50 .00 .00 .00 1.00 .00 .00 1.00 .00 .00 1.00 .00 .00 1.00 .00 .00 1.0 .00 .00 .00 5,60 .00 .00 .00 .00 .00 .00 .00 ---EOR-----EOF---

### ENTECH ENGINEERING, INC. P101-EC3 - Page B.3-2

Page 95

1 8ISTPNBLNUCLIDE LIBRARY FOR ALL DOSE PROGRAMS 89 3 1.78E-090.00E+000.00E+00 SOLUBLE 1 H 9.0E-01 9.0E-01 9.0E-01 9.0E-01 9.3E-01 9.3E-01 4.8E-00 1.0E-02 1.2E-02 0. 1.05E-071.05E-071.05E-071.05E-071.05E-071.05E-07 1.58E-071.58E-071.58E-071.58E-071.58E-071.58E-07 0. 1.06E-071.06E-071.06E-071.06E-071.06E-071.06E-07 ٥. ٥. 1.59E-071.59E-071.59E-071.59E-071.59E-071.59E-07 0. 2.03E-072.03E-072.03E-072.03E-072.03E-072.03E-07 Ο. 3.04E-073.04E-073.04E-073.04E-073.04E-073.04E-07 3.08E-073.08E-073.08E-073.08E-073.08E-073.08E-073.08E-07 0. 4.62E-074.62E-074.62E-074.62E-074.62E-074.62E-07 0. SOLUBLE 6 14 3.83E-12 C 4.6E+03 9.1E+03 4.6E+03 1.8E+03 1.4E+03 1.8E+03 5.5E+00 1.2E-02 3.1E-02 2.84E-065.68E-075.68E-075.68E-075.68E-075.68E-075.68E-07 2.27E-064.26E-074.26E-074.26E-074.26E-074.26E-074.26E-074.26E-07 4.06E-068.12E-078.12E-078.12E-078.12E-078.12E-078.12E-07 3.25E-066.09E-076.09E-076.09E-076.09E-076.09E-076.09E-07 1.21E-052.42E-062.42E-062.42E-062.42E-062.42E-062.42E-06 9.70E-061.82E-061.82E-061.82E-061.82E-061.82E-061.82E-061 2.37E-055.06E-065.06E-065.06E-065.06E-065.06E-065.06E-06 1.89E-053.79E-063.79E-063.79E-063.79E-063.79E-063.79E-06 11 24 1.28E-052.50E-08 2.90E-08 SOLUBLE ETC (FOR A TOTAL OF 89 NUCLIDES) ---EOR-----EOF---1 3VYXQF VY X/QFILE - SPECIAL VALUES - SEWAGE CONTAN. PROBLEM - 2 ACRE PLOTS 4.626E-04 4.626E-04 1.236E-04 4.626E-04 FLD 0 00W MEAT --- EOR------EOF---ENTECH ENGINEERING, INC. P101-EC3 - Page B.3-3



Richard Emch -

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		FROGRAH ATHODOJ E Atoric Electric Company BEC, 1985 Rev. 7		
	REGULATORY GUIDE 1.10%, APPENDIX C Morels for calculating dose via Advitional Pathways from Radioiodunes and other Radiomuclipes Discharged to the Atmosphere Nov.1977 Likkary		3ECTOR FLD DI3TANCE - X/U - 4.63 X/O DEFLETED - 4.63 DELTA - 1.24	0 (NETEKS) E-04 (SEC/N-3) E-04 (SEC/N-3) E-04 (SEC/N-3)
			VV - SEWAGE CONTAK - Acres - Shield F -	SOLIDS 12 67 MT - 2 0.012 - 104 HR DECUP
	THE FOLLOWING I HUGLIDES WERE USED IN THIS CALCULATION	i	ۀ	FATHWAYS CONSIDERED
	NUCLIRE RELEASE EURIES 27 CD 60 2.JIE-04		111 31 CQ 00	DUND FLANE TES MALATION TES DEED VEGETABLES VES AFF VEGETABLES VES W KILK TES M KILK NO AT TES
ENTECH ENG P101-EC3 -	STOKED VV AGRICULTURAL PRODUCTIVITY (KG/H-2) 7.00 P SOIL SURFACE DENSITY (KG/H-2) 740.00 T TRANSPORT TIME TO USER (MRS) TS SOIL EXPOSURE TIME (MRS) 5766.00 TE CROP EXPOSURE TIME TO PLUME (MRS) 5766.00 TE CROP EXPOSURE TIME TO PLUME (MRS) 5766.00 OF ANIMALS DAILY FEED (KG/DAY) FF FRACTION OF TEAR ON PASTURE FS FRACTION OF TEAR ON PASTURE FG FRACTION OF STOREP VEO GROWN IN GARDEN FL FRACTION ELEMENTAL IODINE500 M ABSOLUTE HUMIDITY500 M ABSOLUTE HUMIDITY500 FG FRACTIONAL EQUILIBRIUM RATIO FOR C-14 - 1.000	TABLES         CDU         HILK           LEAFY         FASTUKE         STOKED           2:00         .70         2:00           48:00         46:00         87:66:00           6744:00         87:66:00         7:00:00           1:00         .00         1:00           1:00         1:00         1:00	76 7.00 240.00 240.00 2 45.00 45.00 4 5765.00 8766.00 87 .00 .00 .00 2160.00 6.00 6.00 .50 1.00	MEAT STURE STOKEN .70 2.00 160.00 240.00 160.00 8766.00 .00 8766.00 .00 2160.00 50.00 50.00 .50 1.00
GIN	USAGE FACTORS \$		ERED TO EACH ORGAN Pathways Courthed	8
VEERING, Page B.	(KQ/YR) (KQ/YR) (L1/YR) (KG/YR) (H-J/YR) \$ ADULT 520.00 64.00 310.00 110.00 8000.00 \$ 5.2 TEEN 630.00 42.00 400.00 65.00 8000.00 \$ 5.2 CHILD 520.00 26.00 330.00 41.00 3700.00 \$ 5.2	DE-02 5.376-02 5.208-02 7.4 DE-02 5.448-02 5.208-02 8.4	1E-02 8.30E-02 5.20E-02 0E-02 7.16E-02 5.20E-02	# 5.56E-02 6.12E-02 # 5.73E-02 6.12E-02 # 6.24E-02 6.12E-02 #

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00 A1 A1	GULATORY Dels for Ditional Do other 1 D the athi	CALCULAT FATHWAYS RADIONUCU	ING DOSE FROM RA IDES DIS	VIA DIDIODIN Charged		YANK	EE ATONIC	ELECTKIC CC 1985 REV.		560101 101574/ X/Q X/Q 10 DELTA	NCE . EPLETED .	4.63E-04 (		
												TAM - SOLID F - 0.012		
THE F	OLLOWING	1 NUCLI	IDES WERE	USED IP	THIS CA	LCULATIO	N					6 PATHU	ATS CONSID	EFED
NUCL 30 ZH	C1	RIES JRIES JOE-06										GROUND F Innalati Stored V Leafy Ve Cou Milk Goat Mil Neat	ON EGETAPLES GETAPLES	YES YES YES YES YES NO YES
F S T TT S TE C TH H QF A FF FF FS F FL F FI A	RLE GRICULTUN DIL GURF (RANSFDRT SOIL EXFO SOIL EXFO INIMALS DI (RACTION I (RACTION I (RACTION I (RACTION I (RACTION I (RACTION I (RACTION I (RACTIONA)	ACE RENS TIME TO SURE TIME SURE TIME SURE TIME TER HARVE AILY FEEL OF YEAR ( PASTURE ) OF YEAR ( DF LEAFY ELEMENTAL	ITY USER I I TO FLUM EST IM PASTUR WEN ON F D VEG GRO VEG GRO L JODINE = 5.60	(KG) E (KB) E ASTURE IVN IN G VN IN G VN IN G (GM/H-3)	NRDEN D	STORED 2.00 240.00 8766.00 .00 1440.00	TARLES LEAFY 2.00 240.00 8766.00 .00 24.00	COM FASTURE .70 440.00 8766.00 .00 50.00 .50 1.00	/ MILK STORED 2.00 240.00 48.00 8766.00 .00 2160.00 50.00	60AT PASTURE .70 240.00 48.00 8766.00 .00 .00 6.00 .50 1.00	HILK STORED 2:00 240:00 40:00 8766:00 2160:00 6:00	M PASTURE - 70 - 40.00 480.00 8764.00 - 00 - 00 - 50 - 50 - 1.00	EAT STORED 2.00 240.00 480.00 8766.00 00 2160.00 50.00	
TEEN	VEG (KG/YR) 520.00 630.00 520.00	LEAFY	E FACTORS HILK (LI/YR) 310.00 400.00 330.00	HEAT	INHALATI (M-3/YF 8000.0 8000.0 3700.0	8 5 7 DN 2 5 5 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	RONE L 3E-03 1.0 1E-03 1.3		DOSE DELIVER FROM ALL FA DNEY LL BE-03 2.038 LE-02 2.288	RED TO EACH ATHWAYS COM UNG G1-L (HREM) E-04 6.72E E-04 6.72E	DRGAN BINED LI THYRO -03 1.466 -03 1.466	)ID WHDLE P 04 4.87E- 04 7.38E-	03 1.68E	8 8 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
INFAN		.00	330.00	.00	1400.0	0 \$ 6-1 \$	8E-03 2.0	BE-02 1.0:	26-02 1.886	E-04 1.76E	-02 1.468	-04 9.69E-		1

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Richard Emch - bvy 89 59.tif

Page 98

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		YANKEE AT	DEC. 1985					
REGULATORY GUIDE 1.104. AP Moucls for calculating dos aduitional pathways from r and other radionuclides di to the atmosphere Nov.147	E VIA ADIOIODINES Scharged				SECTOR Distanci X/O X/Q depu Relta	= 4.636	0 (METERS) 	
							SOLIDS 12 BY WI 0.012 - 104 HR 1	
THE FOLLOWING 1 NUCLIDES WER	E USED IN THIS CA	LCULATION				6	PATHWAYS CONSIL	DERER
NUCLIDE RELEASE CURIES 53 CS 134 1.72E-06						INI Sti Lei Coi	DUND FLANE Galation DRED Vegetarles Ary Vegetarles J Nilk At Milk At Milk At	YES YES YES YES
VARIABLE YV ADRICULTURAL PRODUCTIVITY	(KB/H-2)	2.00	EAFY FAS	COW HILK TURE STORED .70 2.00	.70	STORED PA	TA3M (134072 34072 00.5 07.	)
<ul> <li>P SOIL SURFACE DEMSITY</li> <li>T RAMSFORT TIME TO USER</li> <li>THE SOIL EXPOSURE TIME</li> <li>TE CROP EXPOSURE TIME TO FLU</li> <li>TH HOLOUP AFTER HARVEST</li> <li>OF ANIMALS DAILY FEED</li> <li>FF FRACTION OF YEAR ON PASTURE</li> </ul>	ME (HRS) (HRS) (KG/DAY) RE	8766.00 87	41 56.00 B76 .00 24.00	0.00 240.00 B.00 48.00 6.00 8766.00 -00 2160.00 0.00 50.00 .50	48.00 8766.00 .00	48.00 40 8766.00 87 .00 2160.00	40.00 240.00 80.00 480.00 66.00 8766.00 .00 .00 .00 2160.00 50.00 50.00 .50	) ) )
FG FRACTION OF STORED VED OR FL FRACTION OF LEAFY VED OR FI FRACTION ELEMENTAL IODINE H ARSOLUTE HUHIDITY • 3.60 FC FRACTIONAL EQUILIBRIUM RA	OWN IN BARDEN * .500 (DH/H-3)	1.00 000	1.00					
USAGE FACTOR	9	\$1155111 5 5		POSE PELIV	FRED TO EACH D Fathways compi	RGAN	************	
VEG LEAFY MILK AGE VEG (KG/YR) (KG/YR) (LI/YR) ADULT 520.00 64.00 310.00 TEEN 630.00 42.00 400.00	110.00 8000.0	# RONE ) # 0 % 5.89E-0 0 # 7.92E-0	4 1.09E-03 4 1.56E-03	5.04E-04 3.2 6.50E-04 3.E	LUNG GI-LLI (MREM) 20E-04 2.42E-0 39E-04 2.44E-0 39E-04 2.38E-0	4 2.27E-04 4 2.27E-04	9.31E-04 2.65E 8.44E-04 2.65E	E-04

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Impact due to Cs 134 in the Septage

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Page 99

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	YAN	FROGRAM Kee Atomic B I'EC+						
REGULATORY GUIDE 1.109, APPENDIX C Hodels for Calculating nose via Additional pathways from radioiodines And other radiomuclines discharged To the Atmosphere Nou-1977 Library					SECTOR Distanci X/O X/O Defi Delta	• 4 .eted = 4	.63E-04 (5	
								17 BY UT - 2 104 HR BCCU
THE FOLLOWING I NUCLIDES WERE USED IN THE	S CALCULATIO	ри					6 FATHWA	YS CONSIDERED
HUCLIDE RELEASE CURIES							GROUND PL	
55 CS 137 9.376-05							STORED VE LEAFY VEG COW MILK GOAT MILK HEAT	GETABLES YES ETABLES YES YES
VARJABLE YV AGRICULTURAL PRODUCTIVITY (KG/H-2) P SOIL SURRACE DENSITY (KG/H-2) TRANSPORT TIME TO USER (KRS) TR SOIL EXPOSURE TIME TO PLUME (KRS) TH HOLDUP AFTER MARVEST (KRS) TH FACTION OF YEAR ON PASTURE FS FRACTION OF YEAR STATURE S FRACTION OF YEAR ON PASTURE S FRACTION OF YEAR S S S S S S S S S S S S S S S S S S S	STDRED 2.00 240.00 8766.00 .00 1440.00 1.400.00	ETARLES LEAFY 2:00 740.00 8766.00 24.00 1.00	PASTURE .70 240.00 48.00 5766.00 .00 .00 .00 .00 .50 1.00	DSE DELIVER	CD TD EACH D	STDREP 2.00 240.00 48.00 5766.00 .00 2160.00 6.00	ME FASTURE 70 240.00 8766.00 8766.00 00 00 50.00 50.00 1.00	STDREN 2.00 240.00 480.00 8766.00 2160.00 2160.00 50.00
VED LEAFY MILK MEAT INHA	# LATION #		1	ROM ALL PA	THWAYS COMBI	VE D		
ABULT 520.00 64.00 310.00 110.00 80 TEEN 630.00 42.00 400.00 65.00 80 CHILD 520.00 26.00 330.00 41.00 37	00.00 # 5.	57E-02 4.70 57E-02 7.18 53E-01 1.18	E-02 2.78	( -02 9.796 -02 1.396 -02 1.836	INO GI-LLI MREH) (-03 5.868-0) (-02 6.008-0) (-02 5.768-0) (-02 5.768-0)	5.04E-0 5.04E-0 5.04E-0	3 2.83E-0 3 2.18E-0	2 5.90E-03 2 5.90E-03 2 5.90E-03
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			PROGRAM A			
	REDULATORY GUIDE 1.109, APPENE Models for Calculating dose vi Additional pathways from Radio And other Radionuclides discha To the Atkosphere Hou-1977 Li	A IIDDINES RGED	DEC+ 1	985 KEV. 7	X/Q DEFLETED -	FLD 0 (HETER3) 4.63E-04 (3EC/8-3) 4.63E-04 (3EC/8-3) 1.24E-04 (12K1-2)
						TAN - SALIDS 12 RV WT - 2 F - 0.012 - 104 NR DACUP
	THE FOLLOWING S-NUCLIDES WERE US	ED IN THIS CALC	ULATION			& FATHWAYS CONSIDERED
	NUCLIDE RELEASE CURIES 75 HN 54 4.13E-04 77 CO 60 2.51E-04 30 ZN 65 4.50E-06 55 CS 134 1.72E-06 55 CS 137 9.37E-05					JROUND PLANE "ES Inhalation "ES Stored Vfgetarles "ES Leafy Vggetarles tes "Cou xilk" tes Goat Milk No Heat Yes
	VARIABLE TV AGRICULTURAL PRODUCTIVITY	(KO/M-2) S	VEGETARLES Tored Leafy 2.00 2.00	COW MILK Pasture Stored .70 2.00	GDAT HILK Pasture Stored .70 2.00	MEAT Fasture Stored .70 2.00
	P SOIL SURFACE DENSITY T TRANSPORT TIME TO USER TR SOIL EXPOSURE TIME TE CROP EXPOSURE TIME TO PLUME	(KG/M-2) 2- (HRS)	40.00 240.00 66.00 8766.00 .00 .00	240.00 240.00 48.00 48.00 8766.00 8766.00 .00 .00	240.00 240.00 46.00 48.00 8766.00 8766.00 .00 .00	240.00 240.00 480.00 480.00 8766.00 8766.00 .00 .00
	TH HOLDUP AFTER HARVEST		40.00 24.00	.00 2160.00 50.00 50.00	.00 2160.00 6.00 6.00	.00 2160.00 50.00 50.00 .50
ENTE PIOJ	OF ANIMALS DAILY FEED FF FRACTION OF YEAR ON PASTURE FS FRACTION PASTURE WHEN ON FAST			.50 1.00	1.00	
NTECH EN P101-EC3	OF ANIMALS DAILY FEED FF FRACTION OF YEAR ON FASTURE	URE IN GARDEN IN GARDEN .500 I/H-3]	1.00 1.00			
NTECH E P101-EC3	DF ANIAALS DAILY FEED FF FRACTION OF YEAR ON FASTURE FS FRACTION FASTURE WHEN ON PAST FD FRACTION OF STORED VED GROWN FL FRACTION OF LEAFY VEG GROWN FI FRACTION ELEMENTAL IODINE = M ARSOLUTE MUNTIDITY = 3.60 (GM	URE IN GARDEN .500 //H-31 FOR C-14 = 1.00	1.00 0 *********************************	1.00 	1.00	

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			DOSES V VARI	ADULT Received From DUS Fathways (Mren)		FLD SECTOR	AT. A DISTANCE	OF O METE
PATHWAY	BONE	LIVER	KIDNEY	LUNG	81-LLI	THYROID	WHOLE FORY	SKIN
GROUND FLANE								
54 MN							2.13E-04	2.50E-04
A0 CO							5.20E-02	6.12E-02
45 ZN							1.46E-04	1.66E-04
134 CS							2.27E-04	2.632-04
137 CS							5.04E-03	5.908-03
TOTAL FOR FATHWAY							5.76E-02	6.7BE-07
INHALATION							÷	
54 MM	.00€+00	2.40E-06	5.96E-07	8.48E-05	4.69E-06	.00E+00	3.818-07	
40 CD	.00E+00	4.246-05	.00E+00	2.20E-02	1.006-03	.00E+00	5.45E-05	
45 ZN	2.148-06	6.816-06	4.55E-06	5.702-05	3.536-06	.00E+00	3.07E-06	
134 CS	9.386-06	2.13E-05	7.228-06	2.45E-06	2.628-07	.00E+00	1.836-05	
137 CS	6.57E-04	8.53E-04	3.05E-04	1.03E-04	1.15E-05	.00E+00	3.88E-04	
TOTAL FOR FATHWAY	6.69E-04	9.26E-04	3.18E-04	2.226-02	1.07E-03	.00E+00	6.64E-04	
STORED VEGETABLES								
54 MN	.00E+00	8.805-03	2.628-05	.00E+00	2.70E-04	.002+00	1.686-03	
60 CC	.00E+00	1.246-03	.00E+00	.00E+00	2.33E-02	.00E+00	2.74E-03	
43 ZM	1.23E-03	3.906-03	2.612-03	.00E+00	2.46E-03	.00E+00	1.76E-03	•
134 CS	2.30E-04	5.448-04	1.77E-04	5.87E-05	9.368-06	.00€+00	4.476-04	
137 CS	1.976-02	2.698-02	9.15E-03	3.04E-03	5.226-04	.00E+00	1.76E-02	
TOTAL FOR PATHWAY	2.126-02	3.27E-02	1.20E-02	3.10E-03	2.66E-02	.002+00	2.266-02	
LEAFY VEGETABLES			•					
54 MN	.00E+00	1.23E-05	3.672-06	.00E+00	3.785-05	.00E+00	2.36E-06	
40 CO -	.00E+00	1.56E-04	.00E+00	.00E+00	2.936-03	.002+00	3.44E-04	
45 ZH	1.78E-04	5.67E-04	3.80E-04	.00E+00	3.57E-04	.006400	2.56E-04	
134 C8	2.988-05	7.10E-05	2.306-05	7.63E-06	1.248-06	.00E+00	5.80E-03	
137 CS	2.43E-03	3.33E-03	1.13E-03	3.76E-04	6.44E-05	.00E+00	2.182-03	
TOTAL FOR PATHWAY	2.648-03	4.146-03	1-54E-03	3.838-04	3.398-03	.00E+00	2.84E-03	

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			DOSES VARI	ADULT Received from OUS Pathways (Mren)		FLD SECTOR	AT A DISTANCE OF	O NETER
PATHWAY	BONE	LIVER	KIDNEY	LUNG	61-LLI	THYROID	MHOLE BODY	SKIN
CON MILK								
S4 HN	.00E+00	6.781-07	2.028-07	.00E+00	2.08E-06	.00E+00	1.298-07	
60 CD	.00E+00	3.728-05	.00E+00	.00E+00	6.58E-04	.00E+00	6.205-05	
65 ZN	1.49E-03	4.74E-03	3.17E-03	.00E+00	2.99E-03	.00£+00	2.14E-03	
134 CS	8.326-05	1.982-04	6.40E-05	2.136-05	3.46E-06	.00E+00	1.628-04	
137 CS	7.052-03	9.658-03	3.272-03	1.09E-03	1.876-04	.00E+00	6.328-03	
TOTAL FOR PATHWAY	8.632-03	1.465-02	8.51E-03	1.11E-03	3.882-03	.00E+00	8.702-03	
MEAT								
54 MN	.00E+00	7.40E-07	2.20E-07	.00E+00	2.27E-06	.00E+00	1.412-07	
40 CD	.00E+00	1.70E-04	.00E+00	.COE+00	3.20E-03	.00E+00	3.76E-04	
65 ZN	3.86E-04	1.236-03	8.22E-04	.00E+00	7.75E-04	.00E+00	5.56E-04	
134 CS	9.67E-06	2.30E-05	7.4SE-06	2.47E-06	4.03E-07	.00E+00	1.88E-05	
137 CS	B.33E-04	1.14E-03	3.876-04	1.29E-04	2.216-05	.00E+00	7.46E-04	
TOTAL FOR PATHWAY	1.23E-03	2.54E-03	1.226-03	1.31E-04	4.00E-03	.00E+00	1.70E-03	
TOTAL ALL PATHS	3.432-07	5.508-02	2.15E-02	2.69E-02	3.89E-02	.00E+00	9.426-02	6.78E-02
TOTAL ALL PATHS Including whole Yody dose from Ground Plane Exfosure	9.20E-02	1.13E-01	7.92E-02	B.46E-02	9.665-03	5.768-02	9.422-02	

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			DOSES U Vari	TEEN Received from DUS Fathways (MREM)		FLD SECTOR	AT A DISTANCE	0F 0 H
PATHUAY	RONE	LIVER	KIDNEY	LUNG	GI-LLI	THYROID	WHOLE PODY	SKIN
GROUND PLANE								
54 MN							2.136-04	2.50E-04
40 CO							5.206-02	6.12E-02
65 ZN							1.462-04	1.68E-04
134 68							2.278-04	2.65E-04
137 CS							5.06E-03	5.90E-03
TOTAL FOR FATHWAY							5.768-02	6.782-02
INHALATION								
54 MN	.00E+00	3.10E-06	7.71E-07	1.20E-04	4.05E-06	.00E+00	5.092-07	
60 CO	.COE+00	5.57E-05	.00E+00	3.21E-02	9.548-04	.00E+00	7.31E-05	
65 ZH	2.55E-06	8.82E-06	3.70E-06	8.192-05	3.08E-06	.005+00	4.12E-06	
134 CS	1.26E-05	2.84E-05	9.44E-06	3.48E-06	2.45E-07	.00E+00	1.385-05	
137 C9	♥.21E-04	1.16E-03	4.18E-04	1.66E-04	1.168-03	.00E+00	4.276-04	
TOTAL FOR PATHWAY	*.362-04	1.268-03	4.33E-04	3.25E-02	9.73E-04	.00E+00	5.19E-04	
STORED VEGETABLES								
54 MM	.00E+00	1.385-04	4.11E-03	.00E+00	2.828-04	.00E+00	2.736-05	
40 CO	.00E+00	1.97E-03	.00E+00	. DOE +00	2.57E-02	.00E+00	4.45E-03	
65 ZN	1.77E-03	6-136-03	3.93E-03	.00E+00	2.402-03	.00E+00	2.862-03	
134 CS	3.748-04	8.81E-04	2.802-04	1.078-04	1.106-05	.005400	4.092-04	
137 CS	3.356-02	4.46E-02	1.528-02	5.902-03	6.35E-04	.00E+00	1.55E-02	
TOTAL FOR PATHWAY	3.578-02	5.37E-02	1.94E-02	6.016-03	2.928-02	.00E+00	2.33E-02	
LEAFY VEGETABLES								
SA MN	.00E+00	1.05E-03	3.12E-06	.00E+00	2.15E-05	.00£+00	2.07E-06	
40 CO	.00E+00	1.34E-04	.00E+00	.00E+00	1.70E-03	.00E+00	3.03E-04	
65 ZH	1.39E-04	4.84E-04	3.10E-04	.00E+00	2.05E-04	.002+00	2.26E-04	
134 CS	2.63E-05	6.202-05	1.972-05	7.522-06	7.71E-07	.001400	2.88E-05	
137 CS	2.246-03	2.99E-03	1.028-03	3.956-04	4.20E-05	.00E+00	1.04E-03	
TOTAL FOR FATHWAY	2.41E-03	3.682-03	1.356-03	4.028-04	2.028-03	.00E+00	1.60E-03	

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FATHWAY			TEEN Poses Keceived From Various Pathwats (Inten)			FLD SECTOR AT A DISTANCE OF		0 HETERS
	BONE	LIVER	KIDNEY	LUNG	GI-LLI	THYROID	MHOLE BODY	SKIN
CON HILK								
S4 HH	.00E+00	1.13E-06	3.378-07	.00E+00	2-328-04	.00E+00	2.24E-07	
40 50	.00E+00	4.308-05	.00E+00	.00E+00	8.70E-04	.002+00	1.428-04	
65 ZN	2.278-03	7.556-03	5.098-03	.00E+00	3.362-03	.00E+00	3.71E-03	
134 65	1.446-04	3.40E-04	1.085-04	4.12E-05	4.232-06	.00E+00	1.58E-04	
137 CS	1.28E-02	1.70E-02	5.79E-03	2.25E-03	2.42E-04	.00E+00	5.936-03	
TOTAL FOR FATHWAY	1.528-02	2.54E-02	1.106-02	2.29E-03	4.43E-03	.002+00	9.73E-03	
NEAT 54 MN	.00E+00	5.638-07	1.686-07	.00E+00	1.166-06	.002+00	1.12E-07	
	.002+00	1.378-04	+00E+00	.00E+00	1.722-03	.002+00	2.986-04	
		1.31E-04	6.04E-04	.00E+00	4.002-04	.002+00	4.402+04	
65 ZN	2.72E-04	1.010-05	5.75E-06	2.206-06	2.252-07	.00€+00	8.40E-06	
134 CS 137 CS	7.69E-06 6.92E-04	9.206-04	3-13E-04	1.226-04	1.316-05	.00E+00	3.216-04	
TOTAL FOR FATHWAY	9.712-04	2.01E-03	P.23E-04	1.24E-04	2.14E-03	.002+00	1.076-03	
TOTAL ALL PATHS	5.528-02	8.61E-02	3.312-02	4.138-02	3.885-02	.00E+00	9.41E-02	6.788-02
TOTAL ALL PATHS Including whole								
BODY DOSE FROM Ground Plane Exfosure	1.13E-01	1.44E-01	9.08E-02	9.90E-02	9.65E-02	3.76E-02	9.412-02	

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CHILD POSES RECEIVED FROM FLD SECTOR AT A DISTANCE OF O NETERS VARIOUS PATHWAYS (BREM) FATHWAY LIVER LUNG BONE KIDNEY BI-LLI THYRDID WHOLE PODY SKIN GROUND PLANE 54 MN 60 CD 45 ZN 134 CS 2.138-04 2.508-04 5.20E-02 4-12E-02 1.46E-04 1.68E-04 2.278-04 2.658-04 137 CS 5.068-03 5.90€-03 TOTAL FOR PATHWAY 5.76E-01 6.78E-02 INHALATION 34 NN 60 CO .002+00 2.602-06 4.08E-07 9.558-05 1.39E-06 3.54E-04 .00E+00 5.768-07 .00E+00 4.84E-05 .00E+00 2.402-02 B.34E-03 4.64E-06 5.65E-06 .00E+00 4.578-05 1.082-04 65 ZH 2.812-04 7.478-06 4.71E-06 .00E+00 2.558-05 8.312-06 3.04E-06 .002+00 1.64E-05 9.686-08 137 CS 1.752-03 1.13E-03 3.88E-04 1.436-04 4.978-04 .DOE+00 1.76E-04 TOTAL FOR FATHWAY 1.246-03 1.226-03 4.01E-04 2.638-02 3.628-04 .00E+00 2.718-04 STORED VEGETABLES 54 HH 60 CO 65 ZH .00E+00 2.06E-04 5.782-05 .005+00 1.732-04 .00E+00 5.47E-05 .00E+00 3.078-03 .002+00 .00E+00 1.70E-02 .00E+00 9.05E-03 3.472-03 9.24E-03 5.828-03 .00E+00 1.628-03 .00E+00 5.758-03 134 CS 137 CB 8.43E-04 1.428-03 4.378-04 1.582-04 7.64E-06 .00E+00 2.998-04 7.74E-02 4.84E-04 8.082-02 2.526-02 9.072-03 .002+00 1-14E-02 TOTAL FOR PATHWAY 8.528-02 9.138-02 3.15E-02 9.236-03 1.535-02 .002+00 2.668-02 LEAFY VEGETABLES 54 MH .00E+00 1.178-05 3.276-04 .00E+00 9.86E-06 .00E+00 3-136-06 60 CD .001100 1-578-04 .00E+00 3.44E-04 .00E+00 8.688-04 .00E+00 4.628-04 3.40E-04 65 ZN 134 CS 2.05E-04 5.46E-04 .00E+00 9.60E-05 .00E+00 .00E+00 1.582-05 2.326-03 8.32E-06 4.03E-07 4.56E-05 7.48E-05 4.556-04 2.436-05 .00E+00 5.73E-04 137 CS 4.06E-03 3.88E-03 1.27E-03 .00E+00 1.396-03 TOTAL FOR PATHWAY 4.316-03 4.67E-03 1.64E-03 4.648-04 9.998-04

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				DOSES VARI	CHILD RECEIVED FROM OUS FATHWAYS (MREM)		FLD SECTOR	AT A DISTANCE OF	O METERS
FATHUA	NY.	PONE	LIVER	KIDNEY	LUNG	6I-LL I	THYRDID	WHOLE PODY	SKIN
CO¥ 11	tl.K						•		
	MN	.00E+00	1.692-06	4.74E-07	.00E+00	1.476-06	.00E+00	4.50E-07	
	co	.002+00	9.785-05	.00E+00	.00E+00	5.42E-04	.00E+00	2.89E-04	
	ZN	4.496-03	1.202-02	7.54E-03	.00E+00	2.108-03	.00E+00	7.44E-03	
134	ČS.	3.336-04	5.47E-04	1.69E-04	6.08E-03	2.958-06	.00E+00	1.138-04	
	CS	3.082-02	2.95E-02	9.61E-03	3.46E-03	1.85E-04	-00E+00	4.35E-03	
TOTAL	FOR PATHWAY	3.56E-02	4.210-02	1.732-02	3.52E-03	2.83E-03	.00E+00	1.226-02	
								,	
HEAT									
	MN	.00E+00	6.46E-07	1.812-07	.00E+00	5.428-07	.00E+00	1.722-07	
60	C0	.00£+00	1.578-04	.00E+00	.00E+00	8.70E-04	.00E+00	4.63E-04	
65	ZN	4.082-04	1.09E-03	6.84E-04	.00E+00	1.915-04	.00E+00	6.76E-04	
	C S	1.365-05	2.23E-05	6.90E-06	2.48E-06	1.206-07	.00E+00	4.705-06	
137	CS	1.27E-03	1.226-03	3.97E-04	1.43E-04	7.64E-06	.00E+00	1.805-04	
TOTAL	FOR PATHWAY	1.702-03	2.49E-03	1.09E-03	1.458-04	1.072-03	.00E+00	1.326-03	
TOTAL	ALL FATHS	1.285-01	1.426-01	5.20E-02	3.97E-02	2.458-02	.00E+00	9.94E-02	6.78E-02
INCLUD BODY D	ALL PATHS DING WHOLE DDSE FROM D PLANE URE	1.865-01	1.99E-01	1.10E-01	9.73E-02	8.226-02	5,76E-07	P.94E-02	

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			DOSES	INFANT Received from OUS Fathways		FLD SECTOR	AT A DISTANCE	0F 0 HET
				(AREM)				
FATHWAY	BONE	LIVER	KIDHEY	LUNG	61-LL1	THYROID	MHOLE NODY	SKIN
GROUND PLANE								
54 MN							2.13E-04	2.50E-04
60 CD							5.208-02	6.12E-02
65 ZN							1.46E-04	1.68E-04
134 CS							2.27E-04	2.658-04
137 · CS							5.06E-03	5.908-03
TOTAL FOR PATHWAY							5.762-02	6.785-02
INHALATION							•	
54 KN	.00E+00	1.546-06	3.028-07	6.04E-03	4.2BE-07	.00E+00	3.028-07	
40 CQ	.00E+00	2.958-05	.00E+00	1.666-02	1.186-04	.00E+00	4.34E-05	
65 ZN	1.282-06	4.13E-06	2.14E-06	4.278-05	3.398-06	.002+00	2.05E-06	
134 CS	7.968-06	1.778-05	4.79E-06	2.002-04	3.342-08	.000+00	1.876-04	
137 CS	7.54E-04	8.402-04	2.37E-04	9.792-03	1.832-06	.00E+00	6.25E-05	
TOTAL FOR FATHWAY	7.652-04	B.73E-04	2.44E-04	1.682-02	1.238-04	.00E+00	1.10E-04	
STORED VEGETAPLES								
54 MN	.00£+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00£+00	
40 CD	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
45 ZN	.00E+00	.00€+00	.00E+00	.00E+00	.002+00	.00E+00	.00E+00	
134 CS	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
137 CS	.002+00	.00E+00	. 00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
TOTAL FOR PATHWAY	.00E+00	.00E+00	.00E+00	.006+00	. COE+00	.00E+00	.00E+00	
LEAFY VEGETABLES								
S4 MN	.002+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
60 CO	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
45 ZN	.00E+00	.00E+00	.00E+00	.005+00	.00E+00	.00€+00	.00E+00	
134 CS	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	
137 CS	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	

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TOTAL FOR PATHWAY

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				INFANT				
			VARI	RECEIVED FROM OUS FATHWAYS		FLP SECTOR	AT A DISTANCE OF	O KETER
				(MREN)				
FATHWAY	BONE	LIVER	KIDNEY	LUNG	61-LL I	THYROID	WHOLE BODY	SKIN
CON WILK								
54 MN	.00E+00	3.14E-06	6.97E-07	.00E+00	1.14E-06	.00E+00	7.135-07	
40 CD	.00E+00	2.006-04	.00E+00	.005+00	4.758-04	.00E+00	4.728-04	
45 ZN	6.03E-03	2.071-02	1.00E-02	.00E+00	1.752-02	.00E+00	P.54E-03	
134 CS	5.372-04	1.00E-03	2.586-04	1.065-04	2.728-06	.00E+00	1.012-04	
137 CS	4.928-02	5.768-02	1.546-02	6.25E-03	1.802-04	.00E+00	4.088-03	
TOTAL FOR PATHWAY	5.57E-02	7.94E-02	2.57E-02	6.36E-03	1.816-02	.00€+00	1-428-02	
NEAT								
S4 HN	.00E+00	.00E+00	.00E+00	.00E+00	.00€+00	.002+00	.00E+00	
60 CQ	.00E+00	.00E+00	.00E+00	.00E+00	.005+00	.00E+00	.00E+00	
65 ZN	.00E+00	.00E+00	.005+00	.00E+00	.00E+00	.00E+00	.00E+00	
134 CS	.00E+00	.00E+00	.00E+00	+00E+00	.00E+00	.00E+00	-00E+00	
137 CS	.00E+00	.00E+00	.00E+00	.00E+00	.00[+00	.00E+00	.00E+00	
TOTAL FOR PATHWAY	.00€+00	.005+00	.00E+00	.00E+00	.00E+00	.005+00	.001+300.	
TOTAL ALL FATHS	5.65E-02	B.03E-02	2.60E-02	2.328-02	1.836-02	.002+00	7.19E-02	6.782-02
TOTAL ALL PATHS Including undle Rody Dose From	1.14E-01	1.386~01	8,368-02	8,08E-02	7.598-02	5.76E-02	7.198-02	
GROUND FLANE Exfosure		1.552-01	0.536-01	0.000-01		2.78L VI		

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ENTECH ENGINEERING, INC. P101-EC3 ~ Page B.3.6-9

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-	B.4 ATMODOS - Radiological Impact After Termination of VY
	<u>Control of the Disposal Site (All Nuclides)</u>
	Presented below is a partial listing of the ATMODOS Tape 5 input
	used in this portion of the calculation. It corresponds to the output
	which follows. With the exception of the nuclide data library, a large
	portion of which was deleted due to space limitations, the listing is
	complete.
-	1 1VYPI VY STANDARD PROGRAM INFORMATION FILE VY - SEWAGE CONTAM - SOLIDS 1% BY WT - 2 ACRES - SHIELD F = 0.242 - CONT. COCUP 1200 44.56FRESH .500YESNO NO 0242 1.NO NO NO 0.1.00 EOR EOF
	0 2VYGASRLGAS STK VY 87 1 1 0 87063023: MN54 4.132E-6 25 MN 54 OO60 2.511E-4 27 OO 60
	ZN65 4.502E-6 30 ZN 65 CS134 1.715E-6 55 CS 134 CS137 9.366E-5 55 CS 137
	EOR EOF
	1 5QUERY PATHWAYS: SHORE(1,2,3), BND, ROAD, RES1, RAD, MEAT, GOAT, COW SHORE1 YESYES SHORE2 YESYES SHORE3 YESYES
•	BOUND YESYES ROAD YESYES RFS1 YESYESYES
	RADIUS YESYES MEAT YESYESYES YESYES COAT YESYESYES YES YESYES COW YESYESYESYES YESYES
	EOR EOF 1 6VYUFMAXVY MAXIMUM INDIVIDUAL USAGE FACTORS FOR STANDARD PFORBLEMS
	520.0064.00310.00110.0021.00.0012.00.008000.00630.0042.00400.0065.0016.00.00.0067.00.008000.00520.0026.00330.0041.006.90.00.0014.00.003700.00
	.00 .00 330.00 .00 .00 .00 .00 .00 .00 1400.00 EOR-~ EOF-~
	ENTECH ENGINEERING, INC.

1 7VYGSD VY MAX INDIVIDUAL GAS SITE DATA FILE FOR STANDARD PROBLEMS 2.00 2.00 .70 2.00 .70 2.00 .70 2.00 240.00 240.00 240.00 240.00 240.00 240.00 240.00 240.00 .00 .00 48.00 48.00 48.00 48.00 480.00 480.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 8766.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 2160.00 1440.00 24.00 .00 2160.00 .00 2160.00 .00 .00 50.00 50.00 6.00 6.00 50.00 50.00 .00 .00 .50 .00 .50 .00 .00 .50 .00 1.00 .00 .00 1.00 .00 1.00 .00 .00 .00 .00 .00 .00 .00 .00 1.0 1.00 .00 .00 .00 .00 .00 .00 .00 5.60 ---EOR-----EOF--1 8ISTPNBLNUCLIDE LIBRARY FOR ALL DOSE PROGRAMS 89 1 3 1.78E-090.00E+000.00E+00 SOLUBLE H 9.0E-01 9.0E-01 9.0E-01 9.0E-01 9.3E-01 9.3E-01 4.8E-00 1.0E-02 1.2E-02 1.05E-071.05E-071.05E-071.05E-071.05E-071.05E-07 0. 1.58E-071.58E-071.58E-071.58E-071.58E-071.58E-07 0. 0. 1.06E-071.06E-071.06E-071.06E-071.06E-071.06E-07 0. 1.59E-071.59E-071.59E-071.59E-071.59E-071.59E-07 0. 2.03E-072.03E-072.03E-072.03E-072.03E-072.03E-07 Ο. 3.04E-073.04E-073.04E-073.04E-073.04E-073.04E-07 0. 3.08E-073.08E-073.08E-073.08E-073.08E-073.08E-07 4.62E-074.62E-074.62E-074.62E-074.62E-074.62E-074.62E-07 0. SOLUBLE 6 14 3.83E-12 C 4.6E+03 9.1E+03 4.6E+03 1.8E+03 1.4E+03 1.8E+03 5.5E+00 1.2E-02 3.1E-02 2.84E-065.68E-075.68E-075.68E-075.68E-075.68E-075.68E-075.68E-07 2.27E-064.26E-074.26E-074.26E-074.26E-074.26E-074.26E-074.26E-07 4.06E-068.12E-078.12E-078.12E-078.12E-078.12E-078.12E-07 3.25E-066.09E-076.09E-076.09E-076.09E-076.09E-076.09E-07 1.21E-052.42E-062.42E-062.42E-062.42E-062.42E-062.42E-06 9.70E-061.82E-061.82E-061.82E-061.82E-061.82E-061.82E-061 2.37E-055.06E-065.06E-065.06E-065.06E-065.06E-065.06E-06 1.89E-053.79E-063.79E-063.79E-063.79E-063.79E-063.79E-06 11 24 1.28E-052.50E-08 SOLUBLE 2.90E-08 ETC (FOR A TOTAL OF 89 NUCLIDES) ---EOR-----EOF--1 3VYXQF VY X/QFILE - SPECIAL VALUES - SEWAGE CONTAM. PROBLEM - 2 ACRE PLOTS 0 COW MEAT FLD 3.896E-02 3.896E-02 1.236E-04 3.896E-02 ---EOR------ FOF---

> ENTECH ENGINEERING, INC. P101-EC3 - Page B.4-2

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FROORAN ATHODOS TANKEE ATOHIC ELECTRIC COMPANY DEC: 1985 FEV. 7

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FLD (HETERS) SECTOR DISTANCE - 0 (HETERS) - 3.90E-02 (SEC.'H-3) 
 1/0
 3.90E-02 (SEC/H-3)

 2/0
 DEFLETED
 3.90E-02 (SEC/H-3)

 PELTA
 1.24E-04 (1/H-2)

UY - SENAGE CONTAK. - SOLIDS 12 BY WT -2 Acres - Shield F - 0.242 - Cont. DCCUF

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## & PATHWAYS CONSIDERED

GROUND FLANE	YES
INHALATION	YES
STORED VEGETABLES	YES
LEAFY VEGETABLES	YES
COW HILK	VE 5
GOAT HILK	NO
MEAT	YES

AND OTHER RADIONUCLIDES DISCHARGED TO THE ATMOSPHERE HOU. 1977 LIRGARY

REGULATORY GUIDE 1.109, APPENDIX C Hodels for calculating dose via

26.00

CHILD 320.00

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INFANT

330.00

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41.00

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ADDITIONAL FATHWAYS FROM RADIDIDDINES

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## THE FOLLOWING 5 NUCLIDES WERE USED IN THIS CALCULATION

NUCLIDE	RELEASE
25 MN 54	CURIES 4.136-06
27 60 60	2.51E-04
30 ZN 65	4.506-06
SS ES 134	1.728-06
55 CS 137	9.378-05

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YV         AGRICULTURAL PRODUCTIVITY         (#3/#-2)         2.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00         7.00 <th7.00< th="">         7.00         7.00         <th< th=""><th></th><th>ABLE</th><th></th><th></th><th></th><th></th><th>VEGE</th><th>TABLES</th><th>CON</th><th>HILK</th><th>GDA</th><th>T HILK</th><th>HE4</th><th>т</th></th<></th7.00<>		ABLE					VEGE	TABLES	CON	HILK	GDA	T HILK	HE4	т
F       SUIL SURFACE DENSITY       (KU/H-2)       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       240.00       48.00       48.00       48.00       48.00       48.00       48.00       48.00       48.00       48.00       6764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00						3	TORED .	LEAFY	FASTURE	STORED	FASTURE	STORED	PASTURE	STORED
T       TRANSPORT TIME TO USER       (HRS)       48.00       48.00       48.00       48.00       48.00       48.00       48.00       48.00       48.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       8764.00       87	۲V	AGRICULTUR	AL FRODUC	TIVITY	(8.3)	(M-2)	2.00	2.00	.70	2.00	.70	2.00	.70	2.00
TR SDIL EXPOSURE TIME       (NRS)       B764.00       B766.00       B764.00       B7	F	SUIL SURFA	CE DENSIT	TY .	(KU)	(8-2) 2	40.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00
TE       CROP EXPOSURE TIME TO FLUME       (HRS)       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00	T	TRANSFORT	TIME TO L	ISER		HESI			48.00	48.00	48.00	48.00	480.00	480.00
TH HULDUF AFTER MARVEST (HRS) 1440.00 24.00 .00 2160.00 .00 2160.00 .00 2160.00 FF ANTMAR DALLY FEED (KG/DAY) 50.00 50.00 6.00 6.00 50.00 FF FRACTION OF YEAR ON PASTURE 50 .50 .50 FS FRACTION FASTURE WHEN OH FASTURE 1.00 FG FRACTION OF STORED VED GROWN IN GARDEN 1.00 FL FRACTION ELEAFY VED GROWN IN GARDEN 1.00 FL FRACTION ELEAFY VED GROWN IN GARDEN 1.00 FL FRACTION ELEAFY VED GROWN IN GARDEN 1.00	7 <b>R</b>	SOIL EXPOS	URE TIME			NRS) 87	66.00	5766.00	8766.00	8766.00	8766.00	8766.00	8766.00	8766.00
DF         ANIMALS DAILY FEED         (KG/DAY)         50.00         50.00         6.00         6.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00         50.00					18 4	HRS)	.00	.00	.00	.00	.00	.00	.00	.00
FF FRACTION OF YEAR ON PASTURE				57		HR5) 14	40.00	24.00	.00	2380.00	.00	2160.00	.00	2190.00
FS FRACTION FABTURE WHEN OH FASTURE 1.00 1.00 1.00 FG FRACTION OF STORED VEG GROWN IN GARDEN 1.00 FL FRACTION OF LEAFY VEG GROWN IN GARDEN 1.00 F1 FRACTION ELEMENTAL 1001NE 4 .300	QF	ANIMALS DA	ILY FEED		(KG,	DAY3			50.00	50.00	6.00	4.00	50.00	50.00
FG FRACTION OF STORED VED GROWN IN GARDEN 1.00 FL FRACTION OF LEAFY VED GROWN IN GARDEN 1.00 F1 Fraction Elemental Ioding300	FF	FRACTION C	F YEAR DP	FASTU	×€				.50		.50		.50	
FL FRACTION OF LEAFY VEO BROWN IN GARDEN 1.00 FI FRACTION ELEMENTAL LODINE300	FS	FRACTION F	ASTURE W	IEN ON F	ASTURE				1.00		1.00		1.00	
FI FRACTION ELEMENTAL LODINE500	FG	FRACTION C	F STORED	VEG GRI	DWN IN G	ARDEN	1.00							
	FL	FRACTION C	F LEAFY	VEG GRO	DWH IN GA	RDEN		1.00						
	FI	FRACTION E	LEHENTAL	TODINE	500	)								
		ARSOLUTE H	UNIDITY .	5.60	(GH/M-3)									
FC FRACTIONAL EQUILIBRIUM RATID FOR C-14 ~ 1.000	**						~							
		FRACTIONAL	EQUILIBI	TIN RA	TIO FOR I	-14 - 1.00	0							
		FRACTIONAL				-14 - 1.00		********						
USAGE FACTORS * NOSE VELIVERED TO EACH ORDAN		FRACTIONAL				-14 ~ 1.00			t	OSE DELIV	FRED TO EAC	H ORDAN	********	
USAGE FACTORS * DOSE VELIVERED TO EACH ORDAN * From All Pathways Cdirined			USAGE	FACTORS	1		25975 1 1		t	OSE DELIV	FRED TO EAC	H ORDAN	*******	
USAGE FACTORS T DOSE DELIVERED TO EACH ORDAN VED LEAFY MILK NEAT INHALATION T	FC		USAGE LEAFY	FACTORS	1		25855 2 2 2 5		t	TROM ALL	FATHWAYS CO	H ORDAN HRINED		
USAGE FACTORS & DOSE DELIVERED TO EACH ORDAN VEO LEAFY MILK NEAT INHALATION & AGE VEO LEAFY MILK NEAT INHALATION & AGE VEO STATUTOR ADDRESSION AND ADDRESSION AND ADDRESSION AND ADDRESSION ADDRESS	FC	VEO	USAGE LEAFY VED	FACTOR	NEAT	INNALATION	25+55 2 2 5 5		t	TROM ALL	LUNG GI-	H ORDAN HRINED		
USAGE FACTORS * DOSE DELIVERED TO EACH ORDAN VED LEAFY MILK NEAT INHALATION * FROM ALL PATHWAYS CONBINED AGE VED VED * BONE LIVER KIDNEY LUNG GI-LLI THYRGID WHOLE PODY SK (KG/YR) (KG/YR) (KJ/YR) (KG/YR) *	AGE	VED (Kg/yr)	USAGE LEAFY VEG (KG/TR) (	FACTORS HILK LI/VR)	NEAT (KO/YR)	INHALATION (H-3/YR)	25855 2 2 2 5 5 5 5 5	BONE I	LIVER KIT	NOSE TELIN FROM ALL	VERED TO EAC Fathways CC Lung GI- (Mren)	H ORDAN HIRINED LLI THYRDID	WHOLE BOD	Y SKIN
USAGE FACTORS   USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE FACTORS  USAGE	AGE	VE0 (Kg/yr) T 520.00	USAGE LEAFY VED (KG/YR) ( 64.00	FACTORS HILK LI/VR) 310.00	NEAT (K8/YR) 110.00	INHALATION (M-3/YR) 8000.00	25855 2 2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	BDNE ( 5e+00 1.:	1 LIVER KII 296+00 1.21	POSE TELIN FROM ALL MEY E+00 3.0	FATHWAYS CO LUNG GI- (MREH) 04E+00 1.29	H ORDAH HIBINED LLI THYRDID 8400 1.16840	WHOLE 201 9 1.25E+00	Y SKIN 1.37E+

8000.00 £ 1.302400 1.325400 1.235400 3.915400 1.285400 1.446400 1.245400 1.375400 £ 3700.00 £ 1.405400 1.415400 1.255400 3.395400 1.252400 1.46400 1.251600 1.375400 £ 1400.00 £ 1.25400 1.325400 1.255400 1.255400 1.165400 1.465400 1.4576400 1.375400 £

ENTECH ENGINEERING, INC. P101-EC3 - Pare D.4-3

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			DOSES F Vario	IDULT ECEIVED FROM IUS FATHWAYS MREH)		FLD SECTOR	AT A DISTANCE	OF O KETE
FATHUAY	BONE	LIVER	KIDHET	LUNG	01-LLI	THYROID	WHOLE BODY	SKIN
GROUND FLANE 54 MN							4.30E-03	5.058-03
							1.052+00	1.23E+00
40 CO							2.94E-03	3.382-03
65 ZN							4.586-03	5.34E-03
134 CS 137 CS							1.026-01	1.196-01
137 65							1.16E+00	1.378+00
TOTAL FOR PATHWAY								
INHALATION					3.95E-04	.00E+00	3.21E-05	
54 MN	.00E+00	2.022-04	5.02E-05	7.14E-03 1.85E+00	8.832-02	.002+00	4.59E-03	
40 CO	.00E+00	3.57E+03	.00E+00		2.978-04	.00E+00	2.59E-04	
65 ZN	1.80E-04	5.74E-04	3.832-04	4.802-03	2.205-05	.00E+00	1.54E-03	
134 CS	7.90E-04	1.80E-03	6.08E-04	2.07E-04	9.726-04	.00E+00	4.95E-02	
137 CS	5.538-02	7.188-02	2.57E-02	8.70E-03	7.712-04			
TOTAL FOR FATHWAY	5.63E-02	7.BOE-02	2.6BE-02	1.87E+00	<b>▼.</b> 00E-02	.00E+00	5.59E-02	
STORED VEGETABLES			2.628-05	.00E+00	2.70E-04	.002+00	1.688-05	
S4 HN	.00E+00	8.80E-05		.00E+00	2.336-02	.00E+00	2.748-03	
40 CD	.00E+00	1.24E-03	.00E+00	.00E+00	- 46E - 03	.00E+00	1.76E-03	
45 ZN	1.23E-03	3.90E-03	2.61E-03	5.878-05	9.56E-06	.00E+00	4.47E-04	
134 CS	2.302-04	5.468-04	1.77E-04	3.04E-03	5.228-04	.00E+00	1.76E-02	
137 CS	1.97E-02	2.672-02	9.15E-03	3.042-03	STILL VI			
TOTAL FOR FATHWAY	2.128-02	3.27E-02	1.205-02	3.10E-03	2.66E-07	.00E+00	2.268-02	
LEAFY VEDETABLES	.00E+00	1.236-05	3.67E-06	.00E+00	3.78E-05	.00E+00	2.36E-06	
54 HN	.002+00	1.568-04	.00E+00	.00E+00	2.936-03	.00E+00	3.442-04	
40 CD	1.785-04	5.67E-04	3.80E-04	.00E+00	3.57E-04	.002+00	2.56E-04	
65 ZN	2.982-05	7.10E-05	2.302-05	7.63E-06	1.24E-06	.00E+00	5.80E-05	
134 CS	2.436-03	3.332-03	1.132-03	3.76E-04	6.44E-05	.00E+00	2.186-03	
137 CS	4.43E-03		•••••					
TOTAL FOR FATHWAY	2.64E-03	4.14E-03	1.546-03	3.83E-04	3.396-03	.00E+00	2.84E-03	

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			DOSES R Vario	DULT ECEIVED FROM DUS PATHWAYS (MREM)		FLD SECTOR (	AT A DISTANCE OF	O HETERS
FATHWAY	BONE	LIVER	KIDHEY	LUNG	GI-LLI	THYROID	WHOLE BODY	SKIN
. CON HILK				.00E+00	2.08E-06	.00E+00	1.29E-07	
54 MN	.00E+00	6.78E-07	2.028-07	.00E+00	6.78E-04	.00E+00	8.20E-05	
60 CD	.00E+00	3.72E-00	.00E+00	.002+00	2.99E-03	.00E+00	7.14E-03	
45 ZN	1.496-03	4.74E-03	3.17E-03		3.46E-06	.00E+00	1.67E-04	
134 CS	8.326-05	1.98E-04	6.40E-05	2.136-05	1.872-04	.00E+00	6.32E-03	
137 CS	7.05E-03	9.65E-03	3.27E-03	1.09E-03	1.8.1.04		0.000	
TOTAL FOR FATHWAY	8.632-03	1.46E-02	6.516-03	1.11E-03	3.686-03	.002+00	8.70E-03	
			4					
HEAT	.00E+00	7.40E-07	2.208-07	.00E+00	2.278-06	.00E+00	1.41E-07	
54 MN		1.70E-04	.00E+00	.00E+00	3.208-03	.00E+00	3.76E-04	
60 CD	.00E+00	1.23E-03	8.22E-04	.00E+00	7.75E-04	.00E+00	5.56E-04	
63 ZN	3.86E-04		7.45E-06	2.478-06	4.038-07	.00E+00	1.8RE-02	
134 CS	9.67E-06	2.30E-05	3.872-04	1.292-04	2.216-05	.00E+00	7.46E-04	
137 CS	8.332-04	1.14E-03						
TOTAL FOR PATHWAY	1.23E-03	2.56E-03	1.226-03	1.31E-04	4.002-03	.005+00	1.702-03	
•						.00E+00	1.256+00	1.376+00
TOTAL ALL FATHS	9.008-02	1.328-01	4.505-02	1.88£+00	1.28E-01			
TOTAL ALL PATHS Including whole Rody dise from Ground Plane Exposure	1.25E+00	1.29E+00	1.21E+00	3.04E+00	1.29E+00	1.16E+00	1.25E+00	

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	·		DOSES   Vari	TEEN Received From Jus Pathways (Mrem)		FLD SECTOR AT A DISTANCE OF 0 HETH			
FATHWAY	PONE	LIVER	KIDHEY	LUNG	GI-LLI	THYROID	WHOLE BODY	SKIN	
GROUND FLANE									
S4 MN							4.30E-03	5.0SE-03	
60 CQ							1.05E+00	1.232+00	
65 IN							2.94E-03	3.38E-03	
.134 CS							4.586-03	5.348-03	
137 CS							1.026-01	1.19E-01	
TOTAL FOR FATHWAY							1.16E+00	1.37E+00	
INHALATION									
54 MN	.002+00	2.618-04	6.492-05	1.01E-02	3.416-04	.00£+00	4,298-05		
60 CD 06	.00E+00	4.692-03	.00E+00	2.70E+00	3.04E-02	.00£+00	6.15E-03		
63 ZN	2.142-04	7.43E-04	4.80E-04	6.8°E-03	2.39E-04	.00E+00	3.47E-04		
134 CS	1.062-03	2.39E-03	7.95E-04	3.10E-04	2.07E-05	.00E400	1.16E-03		
137 CS	7.75E-02	5.81E-02	3.526-02	1.406-07	9.31E-04	.00E+00	3.40E-02		
TOTAL FOR PATHWAY	7.68E-02	1.06E-01	3.652-02	I.74E+00	8.20E-02	.00E+00	4.37E-02		
STORED VEGETABLES									
S4 MN	.00E+00	1.388-04	4.116-05	.00E+00	2.82E-04	.00E+00	2 736-05		
60 CO	.00E+00	1.975-03	.00E+00	.00E+00	2.57E-02	.00E+00	4.458-03		
65 ZN	1.778-03	6.13E-03	3.938-03	.00E+00	2.60E-03	.00E+00	2.86E-03		
134 CS	3.74E-04	8.81E-04	2.80E-04	1.07E-04	1.10E-05	.00E+00	4.09E-04		
137 CS	3.358-02	4.468-02	1.522-02	5.90E-03	6.358-04	.00E+00	1.55E-02		
TOTAL FOR PATHWAY	3.57E-02	5.375-02	1.946-02	6.01E-03	2.92E-02	.00E+00	2.JJE-02		
LEAFY VEGETABLES									
54 KN	.00£+00	1.05E-05	3.12E-06	.00E+00	2.15E-05	.00E+00	2.07E-04		
60 CD	.00E+00	1.348-04	.00E+00	.00E+00	1.75E-03	.00E+00	3.03E-04		
65 ZN	1.39E-04	4.64E-04	3.10E-04	.00E+00	2.05E-04	.00€+00	2-26E-04		
134 CS	2.638-05	6.20E-05	1.978-05	7.52E-06	7.71E-07	.00E+00	2.886-05		
137 CS	2.24E-03	2.99E-03	1.02E-03	3.956-04	4.25E-05	.00E+00	1.04E-03	•	
TOTAL FOR FATHWAY	2.418-03	3.68E-03	1.358-03	4.028-04	2.02E-03	.00E+00	1.60E-03		

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				TEEN				
			VARI	RECEIVED FROM OUS FATHWAYS (MREH)		FLD SECTOR	AT A DISTANCE OF	O HETER
FATHUAY	BORE	LIVER	KIDNEY	20110	G1-LL1	THYRDID	MHOLE BODY	SKIN
COW NELK								
S4 AN	.00E+00	1.138-06	3.37E-07	.00E+00	2.32E-06	.00E+00	2.24E-07	
60 00	.00E+00	6.30E-05	.00E+00	.00E+00	8.20E-04	.00E+00	1.426-04	
65 ZN	2.29E-03	7.95E-03	5.07E-03	DOE+00	3.36E-03	.00E+00	3.71E-03	
134 CS	1.44E-04	3.40E-04	1.086-04	4-128-05	4.236-06	.00E+00	1.38E-04	
137 CS	1.28E-02	1.70E-02	5.79E-03	2.25E-03	2.42E-04	+00E+00	5.932-03	
TOTAL FOR PATHWAY	1.52E-02	2.54E-02	1.10E-02	2.296-03	4.43E-03	.00E+00	9.936-03	
neat								
SA MN	.00E+00	5.65E-07	1.685-07	.00E+00	1.162-06	.00E400	1.176-07	
02 06	.00E+00	1.322-04	.00E+00	.00E+00	1.722-03	.00E+00	2.986-04	
45 ZN	2.726-04	9.44E-04	6.04E-04	.00E+00	4.00E-04	.00€+00	4.405-04	
134 CS	7.698-06	1.816-05	5.75E-06	2.202-06	2.256-07	.002+00	8.40E-06	
137 CS	6.72E-04	9.20E-04	3.13E-04	1.228-04	1.316-05	.00€400	3.218-04	
TUTAL FOR PATHWAY	9.71E-04	2.01E-03	9.23E-04	1.248-04	2.14E-03	.00E+00	1.07E-03	
TOTAL ALL FATHS	1.33E-01	1.916-01	6.928-02	2.74E+00	1.206-01	.00E+00	1.246+00	1.376+00
TOTAL ALL PATHS Including whole Body Dose From Ground Plane Exposure	1.305+00	1.352+00	1.23E+00	3.91E+00	1.28E+00	1.16E+00	1.24E+00	

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| | | | VARIO | ECEIVED FROM | | FLD SECTOR | AT A DISTANCE | DF O HET |
|-------------------|----------|----------|----------|----------------------|----------|------------|---------------|----------|
| FATHWAY | BONE | LIVER | KIDHEY | LUNG | 61-LL1 . | THYROID | WHOLE BODY | SKIN |
| GROUND FLANE | | | | | | | 4.302-03 | 5.05É-03 |
| S4 MN | | | | | | | 1.03E+00 | 1.23E+00 |
| 40 CO | | | | | | | 2.94E-03 | 3.386-03 |
| 65 ZN | | | | | | | 4.586-03 | 5.34E-03 |
| 134 CS | | | | | | | 1.022-01 | 1.196-01 |
| 137 CS | | | | | | | | |
| TOTAL FOR FATHWAY | | | | | | | 1.182+00 | 1.376+00 |
| INMALATION | | | | | 1.17E-04 | .002+00 | 4.85E-05 | |
| S4 MN | .00E+00 | 2.19E-04 | 3.12E-05 | 6.04E-03 | 2.986-02 | .00E+00 | 7.022-03 | |
| 40 CO | .00E+00 | 4.07E-03 | .00E+00 | 2.192+00 | T.07E-05 | .00E+00 | 3.718-04 | |
| 65 ZN | 2.37E-04 | 6.30E-04 | 3.972-04 | 5.53E-03 | 8.152-06 | .00E+00 | 4.76E-04 | |
| 134 CS | 1.38E-03 | 2.15E-03 | 7.00E-04 | 2.56E-04
1.20E-02 | 4.19E-04 | .00E+00 | 1.472-02 | |
| 137 CS | 1.05E-01 | 9.54E-02 | 3.27E-02 | 1.102-01 | | | | |
| TOTAL FOR PATHWAY | 1.06E-01 | 1.032-01 | 3.382-02 | 2.226+00 | 3.05E-02 | .00E+00 | 2.286-02 | |
| | | | , | | | | | |
| STORED VEGETABLES | | | 5.782-05 | .002+00 | 1.73E-04 | .00E+00 | 5.49E-05 | |
| 54 MN - | .00E+00 | 2.06E-04 | .00E+00 | .00E+00 | 1.70E-02 | .006+00 | 9.05E-03 | |
| 60 CO | .00E+00 | 3.07E-03 | 5.82E-03 | .00E+00 | 1.626-03 | .00E+00 | 5.75E-03 | |
| 65 ZN | 3.47E-03 | 9.248-03 | 4.39E-04 | 1.586-04 | 7.64E-06 | .001400 | 2.99E-04 | |
| 134 68 | 8.63E-04 | 1.426-03 | 2.522-02 | 9.07E-03 | 4.84E-04 | .00E+00 | 1.146-02 | |
| 137 C5 | 8,082-02 | 7.74E-02 | 1.3.2.01 | | | | | |
| TOTAL FOR PATHWAY | 8.522-02 | 9.13E-02 | 3.10E-02 | 9.23E-03 | 1.93E-02 | .00E+00 | 2.66E-02 | |
| LEAFY VEDETABLES | | | | | 0.015-04 | .00E+00 | 3.13E-06 | |
| 54 HN | .00E+00 | 1.17E-05 | 3.29E-06 | .002+00 | 9.846-06 | .002+00 | 4.62E-04 | |
| 60 CO | .00£+00 | 1.57E-04 | .00E+00 | .00E+00 | 8.68E-04 | | 3.40E-04 | |
| 45 ZH | 2.05E-04 | 5.46E-04 | 3.44E-04 | .00E+00 | 9.40E-05 | .00E+00 | 1.38E-05 | |
| 134 CS | 4.56E-05 | 7.48E-05 | 2.32E-05 | 8.322-06 | 4.032-07 | .00E+00 | 5.732-04 | |
| 137 C8 | 4.06E-03 | 3.886-03 | 1.272-03 | 4.55E-04 | 2.43E-05 | | | |
| TOTAL FOR PATHWAY | 4.312-03 | 4.672-03 | 1.64E-03 | 4.64E-04 | 9.99E-04 | .00E+00 | 1.39E-03 | |

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| | | | DOSES I
Vari | CHILD
RECEIVED FROM
DUS FATHWAYS
(MREM) | | FLD SECTOR | 4T A DISTANCE (| OF O KETERS |
| PATHUAY | PONE | LIVER | KIDHEY | LUNG | 01-LLI | THYROID | WHOLE BODY | SKIN |
| COW MILK | | | | | | | | |
| 54 MN | .00€+00 | 1.698-06 | 4.74E-07 | .00E+00 | 1.428-06 | .002+00 | 4.508-07 | |
| 40 CD | .00E+00 | 9.78E-05 | .001400 | .00E+00 | 5.428-04 | . DOE +00 | 2.89E-04 | |
| 45 ZN - | 4.496-03 | 1.208-02 | 7.548-03 | .00E+00 | 2.10E-03 | .00E+00 | 7.44E-03 | |
| 134 CS | 3.33E-04 | 5.47E-04 | 1.69E-04 | 6.06E-05 | 2.95E-06 | .00E+00 | 1.15E-04 | |
| 137 CS | 3.086-02 | 2.95E-02 | 9.61E-03 | 3.46E-03 | 1.85E-04 | -00E+00 | 4.356-03 | |
| TOTAL FOR PATHWAY | 3.546-02 | 4.21E-02 | 1.738-02 | 3.528-03 | 2.836-03 | .00E+00 | 1.22E-02 | |
| | | | | | | | | |
| MEAT | | | | | | | | |
| 34 MN | .00E+00 | 6.462-07 | 1.01E-07 | .00E+00 | 5;42E-07 | .00E+00 | 1.726-07 | |
| 60 CD | .00E+DO | 1.576-04 | .00E+00 | .00E+00 | B.70E-04 | .00E+00 | 4.63E-04 | |
| 92 IN | 4.08E-04 | 1.09E-03 | 6.84E-04 | .00E+00 | 1.91E-04 | .00E+00 | 6.76E-04 | |
| 134 CS | 1.362-05 | 2.238-05 | 6.90E-06 | 2.48E-06 | 1.206-07 | +00E+00 | 4.70E-06 | |
| 137 CS | 1.27E-03 | 1.222-03 | 3.978-04 | 1.43E-04 | 7.648-06 | .006+00 | 1.802-04 | |
| TOTAL FOR PATHWAY | 1.706-03 | 2.49E-03 | 1.09E-03 | 1.458-04 | 1.076-03 | .00E+00 | 1.322-03 | |
| TOTAL ALL PATHS | 2.336-01 | 2.43E-01 | 8.54E-02 | 2-23E+00 | 5.46E-02 | .002+00 | 1.23E+00 | 1.37E+00 |
| TOTAL ALL FATHS
Including whole
Rody Dose From
Ground Plane
Exfosure | 1.40E+00 | 1.41E+00 | 1.25E+00 | 3-346+00 | 1.226+00 | 1.14E+00 | 1.236+00 | |
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ENTECH ENGINEERING, INC. P101-EC3 - Page B.4-9

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HREN) | | FLD SECTOR | AT A DISTANCE | OF ONE |
|---------------------------|----------|----------|------------------|---|----------|------------|---------------|----------|
| FATHWAY | BONE | LIVER | KIDHEY | LUNG | 6I-LLI | THYRDID | MHOLE BODY | SKIN |
| GROUND PLANE | | | | | | | 4.306-03 | 5.05E-03 |
| S4 MN | | | | | | | 1.050+00 | 1.23E+00 |
| 60 CD | | | | | | | 2.946-03 | 3.385-03 |
| 65 ZN | | | | | | | 4.586-03 | 2.348-03 |
| 134 CS | | | | | | | 1.020-01 | 1.196-01 |
| 137 CS | | | | | | | | |
| TOTAL FOR FATHWAY | | | | | | | 1.16E+00 | 1.37E+00 |
| INHALATION | | | | | 3.602-05 | .00E+00 | 2.548-05 | |
| S4 HN | .00E+00 | 1.29E-04 | 2.54E-05 | 5.10E-03 | 9.902-03 | .00E+00 | 3.652-03 | |
| 60 CB | .00E+00 | 2.49E-03 | .00E+00 | 1.40E+00 | 2.846-04 | .00E+00 | 1.738-04 | |
| 65 ZN | 1.07E-04 | 3.48E-04 | 1-81E-04 | 3.905-03 | | .00E+00 | 1.588-04 | |
| 134 CS | 8.37E-04 | 1.49E-03 | 4.03E-04 | 1.69E-04 | 2.832-06 | .00E+00 | 5.266-03 | |
| 137 CS | 6.35E-02 | 7.086-02 | 1.998-02 | 8.24E-03 | 1.54E-04 | .002700 | 31100 03 | |
| TOTAL FOR PATHWAY | 6.44E-02 | 7.52E-Ò2 | 2.05E-02 | 1.42E+00 | 1.04E-02 | .00E+00 | 7.27E-03 | |
| STORED VEGETABLES | | | | | | | .00E+00 | |
| 54 MN | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | | |
| - | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| | .00E+00 | .00E+00 | .00£+00 | .002+00 | .00E+00 | .00E+00 | .00E+00 | |
| 134 CS | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| 137 CS | | | | | | | | |
| TOTAL FOR PATHWAY | .002+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| | | | | | | | | |
| LEAFY VEDETABLES
54 MN | .00E+00 | .002+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .002+00 | |
| | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| 60 CD | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| 65 ZN . | | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| 134 CS | .00E+00 | .00E+00 | .002+00 | . DOE +00 | .00€+00 | .00E+00 | .00E+00 | |
| 137 CS | .00E+00 | | | | | | | |
| | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | |
| TOTAL FOR PATHWAY | .002400 | | | | | | | |

ENTECH ENGINEERING, INC. P101-EC3 - Page B.4-10

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| | | | DOSES
Vari | INFANT
RECEIVED FROM
OUS FATHWAYS
(MREM) | | FLD SECTOR | AT A DISTANCE OF | O HETE |
|--|-----------|----------|---------------|---|----------|------------|------------------|----------|
| FATHWAY | BONE | LIVER | KIDHET | LUNG | 61-LLI | THYRDID | WHOLE BODY | 5K [N |
| CON HILK | | | | | | | | |
| S4 MN | .00E+00 | 3.14E-06 | 6.97E-07 | .00E+00 | 1.165-06 | .002+00 | 7.13E-07 | |
| 60 CD | .00E+00 | 2.00E-04 | .00E+00 | .00E+00 | 4.756-04 | .00E+00 | 4.728-04 | |
| 45 ZN | 6.03E-03 | 2.07E-02 | 1.005-02 | .00E+00 | 1.756-02 | .00E+00 | 7.546-03 | |
| 134 CS | 5.37E-04 | 1.00E-03 | 2.58E-04 | 1.06E-04 | 2.72E-06 | .002+00 | 1.01E-04 | |
| 137 CS | 4.928-02 | 5.76E-02 | 1.546-02 | 6.200-03 | 1.305-04 | .00€+00 | 4.082-03 | |
| TOTAL FOR PATHWAY | \$.57E-02 | 7.946-02 | 2.57E-02 | 6.36E-03 | 1.816-07 | .00€+00 | 1.428-02 | |
| MEAT | | | | | | | | |
| 54 MN | .00E+00 | .00E+00 | .00E+00 | .00€+00 | .00E+00 | .00E+00 | .00€+00 | |
| 60 CD | .002+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .001+00 | |
| 63 ZN | .00€+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .002+00 | .001+00 | |
| 134 CS | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .00E+00 | .002+00 | .00€+00 | |
| 137 CS | .00E+00 | .00E+00 | .00E+00 | .005+00 | .00E+00 | .00£+00 | .00E+00 | |
| TOTAL FOR FATHWAY | .00E+00 | .00€+00 | .00E+00 | .00E+00 | .00E+00 | .002+00 | .00E+00 | |
| TOTAL ALL PATHS | 1.20E-01 | 1.55E-01 | 4.63E-02 | 1.428+00 | 2.85E-02 | .00E+00 | 1.19E+00 | 1.37E+00 |
| TOTAL ALL PATHS
Including whole
Pody Dose From
Ground Flane
Exposure | 1.28E+00 | 1.326+00 | 1.216+00 | 2.58E+00 | 1.19E+00 | 1.16E+00 | 1.1 7E+00 | |

ENTECH ENGINEERING, INC. P101-EC3 - Page B.4-11

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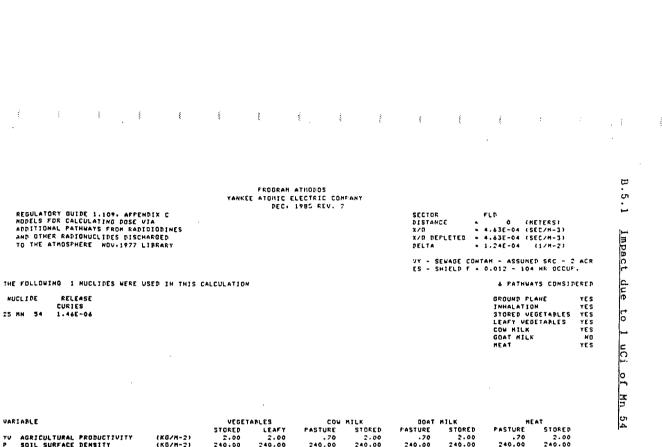
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B.5 <u>ATMODOS - Unplowed-Land Dose Conversion Factors for</u> <u>Radiological Impact Assessment</u>

The Tape 5 inputs to ATMODOS for these cases are identical to the one shown in Attachment B.3, the only exception being the isotopic intensities in File 2. In the current computer runs, each isotope was assumed to have an annual release rate which would yield an accumulated intensity of 1 μ Ci at the end of one year (uniformly spread over 2 acres of unplowed land).

ENTECH ENGINEERING, INC. P101-EC3 - Page B.5-1



| | | | | | 5 | 10660 | LEAFY | PASTURE | 5706 | ED FA | STURE | STORED | PASTURE | STORED |
|-------------|------------------------------------|---|--|--|--|--|---|--------------------------------------|--|--|---|---|---|---|
| YV A | GRICULTUP | RAL PRODL | VTIVITY | (KO/ | 11-2) | 2.00 | 2.00 | .70 | 2. | 00 | .70 | 2.00 | .70 | 2.00 |
| P 5 | OIL SURFA | ACE DENSI | 177 | (KG/ | (H-2) Z | 40.00 | 240.00 | 240.00 | 240. | 00 2 | 40.00 | 240.00 | 240,00 | 240.00 |
| TT | RANSPORT | TIME TO | USER | | HRSI | | | 48.00 | 48. | 00 | 48.00 | 48.00 | 480.00 | 480.00 |
| 18 5 | OIL EXPOS | BURE TIME | E | | (HRS) 87 | 66.00 | 8766.00 | 8766.00 | 8766. | 00 87 | 44.00 8 | 8766.00 | 8766.00 | 8766,00 |
| TE C | ROP EXPOS | SURE TIME | E TO PLU | 4E (| HRS) | .00 | .00 | .00 | | 00 | .00 | .00 | .00 | .00 |
| TH H | OLDUP AFT | TER HARVE | E 57 | (| HRS) 14 | 40.00 | 24.00 | .00 | 2160. | 00 | .00 | 2140.00 | .00 | 2160.00 |
| DF A | HIMALS DA | AILY FEEL | D | (KB/ | (DAY) | | | 20.00 | 50. | 00 | 6.00 | 6.00 | 50.00 | 50.00 |
| FP F | RACTION C | OF YEAR (| ON PASTU | RE | | | | .50 | | | .50 | | .50 | |
| FS F | RACTION P | PASTURE 1 | WHEN ON I | PASTURE | | | | 1.00 | | | 1.00 | | 1.00 | |
| FO F | RACTION 0 | OF STORES | D VEG GRI | OWN IN GA | ARDEN | 1.00 | | | | | | | | |
| FL F | RACTION C | OF LEAFY | VEG OR | JWN IN GA | RDEN | | 1.00 | | | | | | | |
| | | | | 500 | • <sup>-</sup> | | | | | | | | | |
| FI P | RACTION I | LLENENIAL | | | | | | | | | | | | |
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| H A | SOLUTE P | UNIDITY | = 5.60 | (BH/H-3) | Î | 0 | | | | | | | | |
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| TEEN | 630.00 | 42.00 | 400.00 | 45.00 | 8000.00 | # 2.21E-04 | 2.316-04 | 2.218-04 | 3.576-04 | 3.538-04 | 2.21E-04 | 2.43E-04 | 2.60E-04 |
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| | | | | | | 1 | | | FROM | ALL FATHWA | VS CONPINE | D | | |
| | VEG | LEAFT | HILK | HEAT | INHALATION | | | | | | | | | |
| AGE | | VED | | | | 2 | BONE | LIVER | KIDNEY | LUHG | 01-LLI | THYROID | HHOLE BODY | SKIN |
| | (KO/YR) | (KG/TR) | (L1/YR) | (KB/TR) | (M-3/YR) | `£ | | | | INREN | | | | |
| ADULT | 520.00 | 44.00 | 310.00 | 110.00 | | | | | | | | | 1.74E-03 | |
| TEEN | 430.00 | 42.00 | 400.00 | 45.00 | B000.00 | * 1. | 656-03 | 5.57E-03 | 3.401-03 | 8.12E-05 | 2.40E-03 | 5.20E-03 | 2.64E-03 | 5.98E-0 |
| CHILD | 520.00 | 24.00 | 330.00 | 41.00 | | 8 3 | 11E-03 | 8.21E-03 | 5.19E-03 | 7.558-05 | 1.48E-03 | 5.206-05 | 5.128-03 | 5.988-0 |
| INFANT | .00 | .00 | 330.00 | .00 | | 1 2 | 216-03 | 7.44E-03 | 3.636-03 | 8.728-05 | 6.29E-03 | 5.20E-05 | 3.46E-03 | 5.988-0 |
| | | | | | | | | | | | | | | |

ENTECH ENGINEERING, INC. P101-EC3 - Page B.5.3-1

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B.5.4 Impact due to 1 uCi of Cs 134

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| | | YARK | | LECTRIC CO | | | | | |
|---|-------------------------|----------------|----------------|-------------|----------------|-------------------------------------|----------------|---|-----------------------------|
| REGULATORY GUIDE 1.107, AFFEH
Molels for Calculating Dose V
Apritional Fathways from Karia
And Other Karighuclides Disch
To the Athosfnere Mov.1977 L | IA
DIODINES
ARGED | | | 1783 REV. 3 | | SECTOR
DISTAR
270 de
Delta | ICE - | FLN
0 (1
4.032-04 (2
4.032-04 (2
1.346-04 | |
| | | | | | | | | ТАН — ДБЗИК
F — 0.012 - | |
| RE FOLLOWING 1 NUCLIDES WERE U | SED IN 1813 | CALCULATIO | 14 | | | | | 5 FATHP | ATS CUNSID |
| WUCLIDE RELEASE
CURIES
5 CS 134 1.18E-06 | | | | | | | | GROUND PI
Thhelati
Stored V
Leaft Vr
Com Milk
30at Mil
Xeat | ON
EDETABLES
GETABLES |
| N IAPLE | | | TAPLES | | HILK | 6041 | #1LK | к | EAT |
| AGRICULTURAL PRODUCTIVITY | (K0/H-I) | STOKED | LEAFY | FASTURE | STORED | PASTURE | STORED | PASTURE | STORED |
| SOIL SURFACE DENSITY | (68/6-2) | 2,00
240.00 | 2,00
240.00 | .70 | 2,00 | .70
240.00 | 2+00
240,00 | .70 | 2,00
740,00 |
| TRANSFORT TINE TO USER | (HES) | | | 48.00 | 48.00 | 48.00 | 48.00 | 480.00 | 480.00 |
| SOIL EXPOSURE TIKE
Crop exposure tike to fluke | (HRS)
(HRS) | 8766.00
.00 | 00 .00 | 1716.00 | a746.00
.00 | 8766.00
.00 | E764.00
.00 | 00.347J | 0746,00
.00 |
| HOLDUF AFTER HARVEST | (HRS) | 1440.00 | 24.00 | .00 | 2140.00 | .00 | 2160.00 | .00 | 2160.00 |
| ANIMALS DAILY FEED | (KG/DAY) | | | 50.00 | 50.00 | 6.00 | 4.00 | 50.00 | 50.00 |
| FRACTION OF YEAR ON FASTURE
Fraction fasture when on past | THEF | | | .30 | | .50 | | .50 | |
| FRACTION OF STORED VEG GROWN | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| FRACTION OF LEAFY VED GROWN | | | 1.00 | | | | | | |
| FRACTION FLENENTAL IONING # | .500 | | | | | | | | |
| APSOLUTE MUNIPITY = 5.60 (BP | | | | | | | | | |

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| (KG/YR) (KG/YR) (LI/YR) (KG/YR) (M-3/YR) # (M-3/YR) # (MREH)
ADULT 520.00 64.00 310.00 110.00 8000.00 # 4.04E-04 7.46E-04 3.47E-04 2.19E-04 1.56E-04 1.56E-04 6.39E-04 1.83E-
TEEM 630.00 42.00 400.00 65.00 8000.00 # 5.44E-04 1.05E-03 4.46E-04 2.67E-04 1.64E-04 1.56E-04 5.79E-04 1.83E-
CHILD 520.00 26.00 330.00 41.00 3700.00 # 1.03E-03 1.59E-03 6.00E-04 3.15E-04 1.64E-04 1.56E-04 4.58E-04 1.83E- | | | USAGE | E FACTORS | 5 | | 8 | / | DOSE E | DELIVERED T | O EACH ORG | AN | | |
|---|--------|---------|---------|-----------|---------|------------|-------------|----------|----------|-------------|------------|----------|------------|--------|
| AGE VEG VEG (KG/YR) (KG/YR) (LI/YR) (KG/YR) (M-3/YR) BONE LIVER KIDNEY LUMO GI-LLI THYROID WHOLE BODY SKIN ADULT 520.00 64.00 310.00 100.00 B000.00 \$ 4.04E-04 7.46E-04 3.47E-04 2.19E-04 1.66E-04 6.39E-04 1.82E- TEEM 630.00 42.00 8000.00 \$ 5.44E-04 1.07E-03 4.46E-04 1.67E-04 1.67E-04 | | | | | | | | | FROM | ALL FATHWA | YS CONPINE | D | | |
| (KG/YR) (KG/YR) (LI/YR) (KG/YR) (M-3/YR) # (A4E-04 7.46E-04 3.47E-04 2.19E-04 1.66E-04 1.56E-04 6.39E-04 1.82E-
ADULT 520.00 64.00 310.00 110.00 8000.00 # 4.04E-04 7.46E-04 3.47E-04 2.67E-04 1.66E-04 1.56E-04 6.39E-04 1.82E-
TEEN 630.00 42.00 40.00 65.00 8000.00 # 5.44E-04 1.07E-03 4.46E-04 2.67E-04 1.67E-04 1.56E-04 4.57E-04 1.82E-
CHILD 520.00 26.00 330.00 41.00 3700.00 # 1.03E-03 1.59E-03 6.00E-04 3.13E-04 1.56E-04 1.56E-04 4.182E- | | VEG | LEAFY | MILK | NEAT | INHALATION | 8 | | | | | | | |
| ADULT 520.00 64.00 310.00 110.00 8000.00 ± 4.04E-04 7.46E-04 3.47E-04 2.19E-04 1.66E-04 1.56E-04 6.39E-04 1.82E-
TEEN 630.00 42.00 400.00 65.00 8000.00 ± 5.44E-04 1.07E-03 4.46E-04 2.67E-04 1.67E-04 1.56E-04 5.79E-04 1.82E-
CHILD 520.00 26.00 330.00 41.00 1700.00 ± 1.03E-03 1.59E-03 6.00E-04 3.15E-04 1.64E-04 1.56E-04 4.58E-04 1.82E- | AGE | | VEG | | | | 8 BONE | LIVER | KIDNEY | LUNG | 0I-LLI | THYROID | WHOLE BODY | SKIN |
| TEEN 630.00 42.00 400.00 65.00 8000.00 8 5.44E-04 1.07E-03 4.48E-04 2.67E-04 1.67E-04 1.56E-04 5.79E-04 1.82E-
CHILD 520.00 26.00 330.00 41.00 3700.00 8 1.03E-03 1.59E-03 6.00E-04 3.15E-04 1.64E-04 1.56E-04 4.58E-04 1.62E- | | (KG/YR) | (KG/YR) | (L1/YR) | (KG/YR) | (M-3/YR) | | | N | ENKEH |) | | | |
| CHILD 520.00 26.00 330.00 41.00 3700.00 # 1.03E-03 1.59E-03 6.00E-04 3.15E-04 1.64E-04 1.56E-04 4.58E-04 1.82E- | ADULT | 520.00 | 64.00 | 310.00 | 110.00 | 8000.00 | # 4.04E-04 | 7.46E-04 | 3.478-04 | 2.19E-04 | 1.665-04 | 1.56E-04 | 6.398-04 | 1.82E- |
| | TEEN | 630.00 | 42.00 | 400.00 | 65.00 | 8000.00 | \$ 5.44E-04 | 1.078-03 | 4.465-04 | 2.678-04 | 1.678-04 | 1.568-04 | 5.798-04 | 1.826- |
| | CHILD | 520.00 | 26.00 | 330.00 | 41.00 | 3700.00 | # 1.03E-03 | 1.598-03 | 6.00E-04 | 3.15E-04 | 1.64E-04 | 1.566-04 | 4.5BE-04 | 1.826- |
| | INFANT | .00 | .00 | 330.00 | .00 | | | | | | | | | 1.832- |

ENTECH ENGINEERING, INC. Pl01-EC3 - Page B.5.4-1

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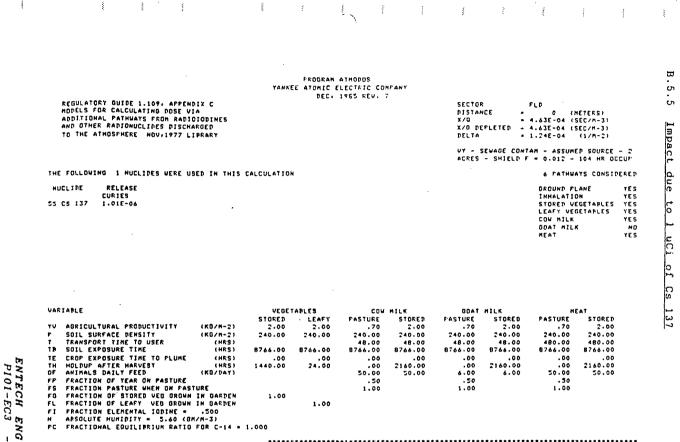
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|--------|---------|---------|---------|---------|------------|----------|----------|-----------|------------|------------|----------|------------|-----------|-----|
| | | USAGI | FACTORS | 3 | | | | DOSE D | ELIVERED T | O EACH ORG | AN | | | |
| | | | | | | | | FROM | ALL FATHWA | YS COMPINE | 0 | | | |
| | VEO | LEAFY | HILK | MEAT | INHALATION | | | | | | | | | |
| AGE | | VEG | | | | RONE | LIVER | KIDNEY | LUNG | GI-LLI | THYRDID | WHOLE BODY | SKIN | |
| | (KG/YR) | (KO/YR) | (LI/YR) | (KO/YR) | (M-3/YR) | | | • | (888) |) | | | | |
| ADULT | 520.00 | 64.00 | 310.00 | 110.00 | 8000.00 | 3.865-04 | 5.07E-04 | 2.09E-04 | 1.06E-04 | 6.33E-05 | 5.46E-03 | 3.52E-04 | 6.37E-03 | |
| TEEN | 630.00 | 42.00 | 400.00 | 63.00 | 8000.00 | 5.978-04 | 7.75E-04 | 3.00E-04 | 1.30E-04 | 6.48E-05 | 5.46E-03 | 3.06E-04 | 6.378-05 | |
| CHILD | 520.00 | 26.00 | 330.00 | 41.00 | 3700.00 | 1.33E-03 | 1.286-03 | 4.538-04 | 1.98E-04 | 6.23E-05 | 5.462-03 | 2.35E-04 | 4.37E-05 | |
| INFANT | .00 | .00 | 330.00 | .00 | 1400.00 | 5.948-04 | 6.86E-04 | 2.246-04 | 1.23E-04 | 5.66E-03 | 5.46E-03 | 9.94E-03 | 6.37E-05 | |
| | | | | | | | | | | | | | | |
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