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National Environmental Studies Project

"de minimus" CONCENTRATIONS OF
RADIONUCLIDES IN SOLID WASTES

Prepared for the
Atomic Industrial Forum

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PREFACE

In a general sense, the term "de minimus" refers to concentrations or quantities of potential pollutants that are present in so minute amounts in a gaseous, liquid or solid waste as to be relatively harmless to man and his environment. In other words, a waste or effluent that meets criteria defining "de minimus" levels should be acceptable for disposal or release without any special precautions or monitoring programs. While wastes and effluents from power reactor operations are generally thought of in terms of their radioactivity content, the concept is equally applicable to such environmental concerns as free residual chlorine, atmospheric and aquatic rejection of waste heat, and the impingement and entrainment of aquatic organisms in cooling water systems.

The concept of "de minimus" concentrations of radionuclides in slightly contaminated solid waste was first brought to our attention about two years ago by several of NESP's sponsors and the Nuclear Regulatory Commission. When funding became available in mid-1977, Nuclear Safety Associates was awarded a contract to investigate existing standards for radioactive materials and other considerations, such as background radiation, for the purpose of identifying criteria that define "de minimus" levels. Once the criteria were defined, the thrust of the study was to develop and apply a generic methodology that could be used for determining whether or not certain slightly contaminated solid wastes were suitable for a "de minimus" radioactivity-level classification.

It is important to note that it was not intended for this investigation to include an evaluation of the overall acceptability or appropriateness of various existing radiation standards or guidelines, such as 40 CFR Part 190 and Appendix I to 10 CFR Part 50, but rather, to use current

regulations as a basis for defining reasonable "de minimus" levels. Hence, it should not be inferred by the reader that the results of the study tacitly endorse the regulations considered. Also, the criteria are presented as a suggested approach to defining "de minimus" levels and do not necessarily represent a consensus position of the nuclear power industry,

For this initial NESP investigation of the "de minimus" concept, PWR spent secondary-side powdered resin was selected as a specific and timely subject that could be used to demonstrate the development and application of a generic methodology. The study was limited to spent powdered resin because of budgetary constraints and the fact that the spent resin example would suitably serve the purpose of illustrating the basic concept. It was found that the methodology is applicable to other solid wastes, e.g., slightly-contaminated soils, dredge spoils and the like. However, because the pathways for dose to man evaluated in this work were selected on the basis of solid waste, the methodology is not complete in terms of its application to wastes other than solids. In the particular case of the "trash" category of solid wastes, the methodology is probably incomplete because of the possibility of incineration and the fact that the methodology does not include this kind of airborne pathway to man. Nonetheless, this should not be interpreted as a major shortcoming in the methodology, because once the user understands its application to solid waste, he can readily include analyses of additional pathways that are relevant to the particular waste being examined.

The limiting radionuclide concentrations for solids presented in this work are thought to be generic and independent of site-specific variables.

For this study, pathways and assumptions were selected in order that variations in individual site characteristics would not appreciably alter the findings. For example, the assumptions made for the "sanitary landfill-leaching into watercourse" pathway analysis, which would usually be considered quite site dependent, were sufficiently conservative that even the limiting radionuclide concentrations stipulated for this pathway can be considered independent of site-specific features. It is also important to recognize that the primary criterion identified in this study for determining "de minimus" levels, which is 1 mrem/year to an individual, was selected on a very conservative basis, and that higher levels of contamination are very likely to be appropriate for some applications of the concept, particularly those involving more controlled waste disposal conditions.

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TABLE OF CONTENTS

	Page No.
1.0 INTRODUCTION	1
2.0 CONCLUSIONS	4
3.0 RADIATION PROTECTION CRITERIA	5
3.1 Introduction	5
3.2 Natural Background Radiation Exposures	6
Sources of Natural Radiation	6
Environmental Variations	7
Implication of Natural Background Exposure	10
3.3 Unregulated, Man-Made Radiation Exposures	12
3.4 Existing Regulations	12
10 CFR Part 20	13
10 CFR Part 30	14
10 CFR Part 50, Appendix I	14
10 CFR Part 71	16
40 CFR Part 190	16
Proposed Federal Guidance on Transuranium Elements in the Environment	17
3.5 Selection of Dose Limits Appropriate for "de minimus" Disposal Concentrations	18
4.0 METHODOLOGY EMPLOYED	22
4.1 Disposal Scenarios	22
4.2 Environmental Pathways	23
4.3 Calculational Technique	25
4.4 Results of Calculations	28
Individual Pathway Evaluation	28
Summary of Most Limiting Cases	28
5.0 COST-BENEFIT CONSIDERATIONS	46
6.0 APPLICATION OF THE GENERIC METHOD	48
6.1 Application to Secondary Resins	48
6.2 Practicability of Measurement	51
REFERENCES	55
APPENDICES	57

LIST OF FIGURES

<u>Figures</u>	<u>Page</u>
3-1 Personal Dose Rates of Ionizing Radiation from Naturally Occurring on Unregulated Sources.....	11
4-1 Summary Diagram of Method of Determining "de minimus" Radionuclide Concentration Limit.....	27
6-1 Summary Diagram of Method of Calculating Whether Waste Is "de minimus".....	49

LIST OF TABLES

<u>Tables</u>	
3-1 Summary of Representative Dose Equivalent Rates in the USA from All Naturally Occurring Radiation Sources.....	21
4-1 Quantities Assigned to Variables in the Evaluation of Postulated Leaching of Radionuclides from a Sanitary Landfill to a Watercourse.....	31
4-2 Example of Computed Concentration Limits for One Disposal Mode-Pathway-Receptor Case.....	32
4-3 Most Restrictive Concentration Limits and Disposal-Pathway-Receptor Combinations Selected from all Computed Cases.....	34
4-4 Most Restrictive Concentration Limits and Disposal-Pathway-Receptor Combinations Selected from All Computed Cases Arranged by Increasing "de minimus" Concentration Limit.....	37
4-5 Most Restrictive Activity Concentration Limits for Solid Waste Disposal in a Sanitary Landfill.....	40
4-6 Most Restrictive Activity Concentration Limits for Solid Waste Disposal in a Sanitary Landfill Arranged by Increasing "de minimus" Concentration Limit.....	43
6-1 Comparison of Computed Activity Concentrations in Spent Resin with "de minimus" Concentration Limits Appropriate for Land Disposal of Homogeneous Bulk Solid Waste.....	52
6-2 Comparison of Computed Activity Concentrations in Spent Resin with "de minimus" Concentration Limits Appropriate for Land Disposal of Homogeneous Bulk Solid Waste.....	53
6-3 Comparison of Computed Activity Concentrations in Spent Resin with "de minimus" Concentration Limits Appropriate for Land Disposal of Homogeneous Bulk Solid Waste.....	54

1.0 INTRODUCTION

In 1977, the National Environmental Studies Project of the Atomic Industrial Forum established a task force to develop the scope of a study aimed at determining levels of radioactivity which could be considered "de minimus", i.e., levels which could be considered "non-radioactive" and such that materials at or below these levels could be released or discarded without restriction. As a result of the work of this task force, Nuclear Safety Associates was commissioned by the Atomic Industrial Forum to carry out such a study, to develop specific recommendations for quantitative "de minimus" levels using spent powdered ion-exchange resins from PWR secondary systems as an example, and to supply the technical and scientific bases for determining and justifying the levels selected.

In the development of the "de minimus" values reported herein, the following basic steps were used:

- Basic radiation protection criteria were identified. Clearly there is a direct relationship between the quantity or concentration of radioisotopes which may be released by any means and the degree of protection which is to be provided to members of the public. Therefore, it is first necessary to establish what the desired degree of protection is. The selection of this criterion is discussed in Section 3 of this report.
- Pathways by which released activity could reach man were identified and described. The major modes by which man may be exposed to ambient radioactivity are: ingestion, inhalation, and direct irradiation. There are also a number of transport mechanisms by which radioactive material may move in the

environment and thus reach man. Some of these are: suspension of solid particles into air, surface runoff with water, transport by groundwater, and physical transport into situations wherein food products may be raised in proximity to the radioactivity. A matrix of exposure pathways was set up to describe all practicable ways by which exposure of man might occur. A discussion of the pathways investigated is given in Section 4.2.

- For each pathway and for each isotope the limiting concentration which allows the selected radiation protection criterion to be met was calculated. For each radionuclide the limiting pathway was determined and the radionuclide limit was set, individually, based upon the most restrictive mode found for that nuclide. A discussion of this calculational technique and of the computer code developed to carry it out is given in Section 4.3. The extensive calculational results are summarized in Section 4.4.
- Consideration was given to whether application of the principle as low as is reasonably achievable (ALARA) would result in limits lower than those resulting from the calculations identified above. It was concluded that ALARA did not result in lower limits than those calculated herein.
- The "de minimus" limits discussed in Section 4 are then applied to a specific case—the disposal of PWR secondary resins. In a specific case, it is possible to compare activity levels to the "de minimus" levels calculated herein and to determine the key radionuclides which dominate that specific case. This is discussed in Section 7.1. Finally, the practicality of the specific application is addressed by considering whether the

normally available analytical capability is able to determine these key isotopes at the required low levels. This is considered in Section 7.2.

The result of this study is the determination within defined conditions of concentrations of essentially all isotopes of interest to the nuclear industry which can be considered "de minimus." The application of the general method to a specific case is illustrated. It is believed that the method is applicable to a wide variety of materials and situations.

2.0 CONCLUSIONS

The major conclusions from this investigation are:

- 1) A suggested appropriate level of protection to be used in establishing "de minimus" concentrations of materials containing trace amounts of radionuclides is a maximum total body dose of 1 mrem/year, or a maximum dose to any organ of 3 mrem/year, to any individual. This level is suggested by the application of the 10 CFR Part 20 provision which permits ignoring isotopic contributions which individually contribute less than 10% to the total dose and which collectively contribute less than 25% to the design guide levels of 10 CFR Part 50, Appendix I.
- 2) For wastes such as PWR secondary resins disposed in soils, it has been shown that four isotopes, Cs-137, Cs-134, Co-60, and Co-58 clearly dominate the dose calculations. Two of these, Co-60 and Cs-137, could be used as "keys" to establish compliance with the suggested limits.
- 3) The concentration levels required to meet the suggested "de minimus" concentrations are in the range of one pCi/gram. For the "key" isotopes, Co-60 and Cs-137, these concentrations are readily measureable with equipment normally available at nuclear reactor sites.

3.0 RADIATION PROTECTION CRITERIA

3.1 Introduction

Appropriate radiation protection criteria are prerequisite to the determination of "de minimus" radionuclide concentrations in any radioactive material. A direct relationship will exist between the concentrations of radioisotopes which may be disposed of without specific controls, i.e., be considered "de minimus" and the degree of protection provided to members of the public.

Existing radiation protection standards are not applicable to routine unrestricted disposal of slightly contaminated nuclear materials. They do, however, serve as references from which to derive "de minimus" criteria compatible with regulatory standards.

The potential for individual and population exposure via any single source should be considered in relation to exposures from other sources, particularly from naturally existing ones. The relative benefits of providing protection against radiation from a specific source may also be judged in perspective with variations in personal exposures from background sources.

Therefore, the radiation protection criteria appropriate for determining the concentrations of radioactivity in slightly-contaminated materials which may be disposed of in an unrestricted manner must be compatible with current or revised standards for protection against radiation. They should also retain perspective in relation to the risk of health effects from natural environmental exposures and variations therein.

3.2 Natural Background Radiation Exposures

The significance of any added exposure potential associated with introduction of radioactivity into the environment should be considered in relation to natural environmental levels of radiation and variations therein. A review of natural sources of radiation exposure and their variability can provide guidance and perspective for selecting the boundary of "de minimus" dose rates from release of radioactive material into the environment.

Sources of Natural Radiation

Naturally occurring radiation in the environment originates from cosmic rays, radionuclides produced by cosmic rays, and from primordial radionuclides in the earth. In the United States, the air dose rates due to cosmic rays vary from about 27 to 95 mrad/yr and the population weighted mean air dose rate has been estimated to be about 29 mrad/yr (NC75). Outdoor exposure rates due to terrestrial radioactivity vary from about 12 to 90 mrad/yr in the US and the population weighted mean is about 44 mrad/yr (NC75).

People are also exposed to natural radiation by internally deposited radionuclides that have been inhaled or ingested as well as to external irradiation. Typical dose equivalent rates to a representative US resident from naturally occurring sources are provided in Table 3-1.* The estimated dose rate from cosmic rays includes a ten percent reduction to account for structural shielding. Irradiation by primordial terrestrial radioactivity includes a 20-percent reduction for shielding by housing and

* Adapted from Ref. NC 75.

a 20 percent reduction for self-shielding by the body. The dose to the lung from inhaled radioactivity is tabulated separately; doses to other tissues from inhaled radioactivity are included with other primordial radionuclides in the body. Estimated doses to the gastrointestinal tract do not include any contribution from radioactivity in the contents of the tract.

Environmental Variations

Individuals and population subgroups within the United States experience dose equivalent rates which vary widely from the average. Large segments of the population experience appreciably different natural exposures. External terrestrial dose equivalent rates experienced by people indoors range from about 15 mrem per year on the Atlantic and Gulf Coast plain to 30 mrem per year in mid-continent and to about 55 mrem per year along the Colorado Plateau (Oa72). Cosmic ray dose equivalent rates experienced by the population range from 26 mrem in Florida to about 50 mrem per year in Denver, Colorado (NC75). Thus natural external radiation doses to large groups in the United States population vary from about 41 to 105 mrem per year by geographic location alone.

Most of the variation in dose due to radionuclides in the body results from variations in Ra-226 in drinking water and in the lung from Rn-222 progeny.

A typical United States resident receives about 16 mrem per year bone dose and about 0.2 mrem per year to soft tissue from ingested radium (UN72). Even if the radium concentration in community water supplies does not exceed the current regulatory limit of 5 pCi/l (EPA76),

dose rates experienced by users could be as much as 1 mrem per year to soft body tissue and about 150 mrem per year to bone from drinking water alone.

An average dose to the lung of about 100 mrem per year from radon progeny inhaled in dwellings has been attributed to construction materials, type of construction, ventilation, and radioactivity in land beneath (NC75). Variations among these influential factors cause lung dose equivalents to vary by a few hundred millirem per year among limited population groups in the United States.

Throughout history, mankind has been exposed to roughly these levels of naturally occurring radiation. In some other parts of the world exposures have been even higher. For instance, along the southeastern coast of India, where thorium-bearing monazite sand is abundant, external exposures to residents from natural radioactivity in the sandy soil ranges up to about 2000 millirads per year. In some towns along the coast of Brazil, external exposures from monazite sand in the soil average 550 millirads per year within a range from 90 to 2800 millirads annually (UN72). Even at these rates, effects on man's health or development have not been detected.

Variations According to Living Habits. Differences in personal living habits also affect exposure to naturally occurring radiation and radioactive material. Within a given locality the construction materials and style of buildings influence indoor radiation exposure rates. Gamma exposure rates in masonry (Oa72) and in slab-on-grade dwellings (Fla77) have been observed to be about the same as in natural outdoor areas surrounding the dwellings. But in wood frame dwellings, gamma exposure rates ranging from 70 to 80 percent of outdoor

levels and averaging closer to 70 percent have been observed (Oa72). Yeates (Ye72) measured gamma radiation intensity reductions of about 25% on the first floor and about 50% on the second floor of wood frame houses. Overall, the difference in direct radiation exposure to persons living and working in wood frame buildings rather than in concrete or masonry buildings can be about 10 millirem per year.

Lung exposure to radon and its progeny may be affected significantly by living habits. For instance, concentrations of Pb-210 and Po-210, both long-lived progeny of Rn-222, have been found to be about 2 or 3 times higher in the lungs and ribs of cigarette smokers than in non-smokers (Ra64, UN72). This amounts to 6 to 9 millirem per year additional dose to the lungs of a smoker, a 5 to 7 percent increase in total lung dose by comparison with a typical non-smoker. If natural gas is used in a residence, lung doses will typically increase by about two percent, i.e., about two millirem per year, as a result (Ba73). Perhaps the greatest influence on naturally occurring lung exposures is ventilation practices in dwellings which alone can influence radon and radon progeny concentrations in a house by a factor of as much as ten (Wi77).

Another activity which affects exposure to naturally occurring radiation is air travel. At the jet cruising altitude, about 33,000 to 39,000 feet, the dose equivalent rate due to cosmic rays is about 0.3 to 0.5 mrem per hour. Based on this, the United States population averaged dose equivalent from commercial air travel is about one millirem annually. However, if a person travels more frequently, e.g., two trips per month of four hours duration each, his annual dose equivalent will be increased by about 30 to 50 millirem.

Where one vacations may also influence his annual radiation exposure. Spending a week skiing in Colorado will deliver about 1.5 millirem more than a week at an Atlantic beach, for instance.

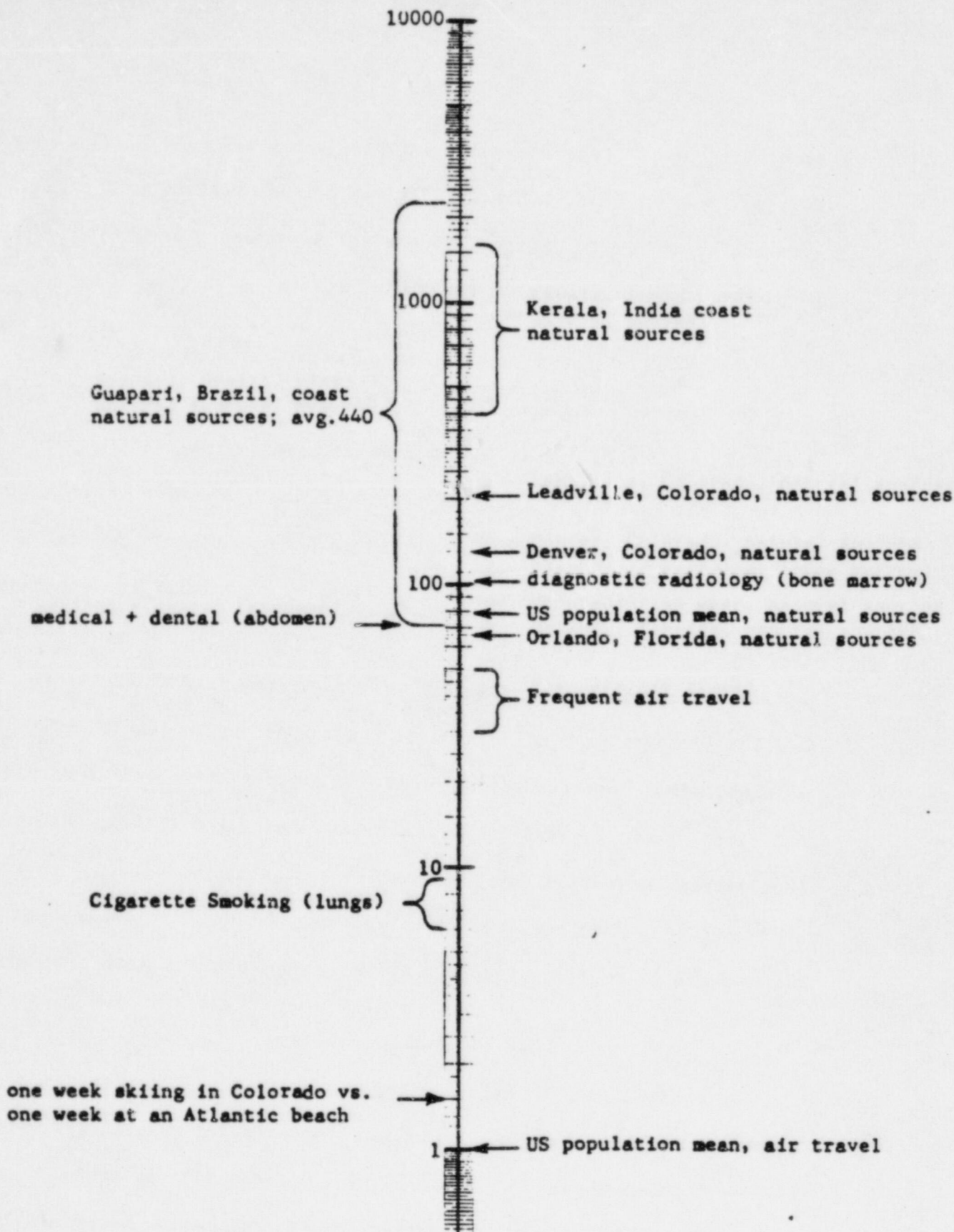
These examples illustrate the effects personal living habits can have upon exposure to naturally occurring radiation and radioactive material. The range and variation in human exposure to natural radiation as consequence of living habits and locations are illustrated in Figure 3-1.

Implication of Natural Background Exposure

Knowledge of population exposure rates from naturally occurring radiation and radioactive materials provides a rational basis for selecting appropriate standards for unrestricted disposal of slightly radioactive material.

It should be remembered that the doses from natural radioactivity and, to a large extent, from medical administration, affect the entire United States population. Conversely, the number of people exposed to "de minimus" concentrations of radioactivity will be small. In fact, a limit on the potential dose to maximally exposed persons should be an adequate criterion for determining appropriate "de minimus" radionuclide concentrations. At such a low individual dose rate, a cost-benefit interpretation based on an estimate of population integrated dose equivalent would be of questionable value in providing guidance (IC73, NC75a).

The range and variation in exposures to natural sources of radiation experienced by the population of the United States suggests "de minimus" dose rate of a few millirem per year to individual members of the



Units: millirem/year

Figure 3-1. Personal Dose Rates of Ionizing Radiation from Naturally Occurring or Unregulated Sources

population are appropriate. For example, three millirem total body dose per year is well within the variation among residents of a given area and is only a few percent of the variation among large groups of people in different parts of the United States.

3.3 Unregulated, Man-made Radiation Exposures

The largest fraction of the man-made radiation exposure to residents of the United States is now administered in the practice of medicine and dentistry. Public exposure from this source exceeds that from other man-made sources by ten to one hundred times. Medical diagnostic radiology accounts for at least 90 percent of the man-made radiation exposure. Estimates based on the 1970 X-Ray Exposure Study were that the per capita mean active bone marrow dose to adults in 1970 was 103 millirem from all diagnostic radiology procedures (Sh76). The mean abdominal dose per capita in the US population in 1970 from medical and dental radiation was estimated to be 72 millirem (G172). Medically-administered radiation doses vary widely among individuals, of course. These estimates of localized doses are roughly equal to the average total body dose a US resident receives annually from natural radiation sources.

3.4 Existing Regulations

As a first step in establishing radiation protection criteria associated with "de minimus" releases, the existing regulations were reviewed. Some aspects of these regulations could be interpreted as establishing "de minimus" concentrations of radioactive materials for disposal. These relevant Federal regulations which influence the choice of radiation protection criteria for establishing "de minimus" concentrations were examined.

Federal Regulations, Title 10, Part 20

The maximum exposure in unrestricted areas permitted by 10 CFR Part 20 is 500 mrem per year to the whole body of any individual (10 CFR Part 20.105). For a population group, the exposure from radioactive materials in effluents may not exceed that which would occur if the group were continuously exposed to air or water concentrations containing one-third of the unrestricted Maximum Permissible Concentration (MPC) (10 CFR Part 20.106). These limitations are subject to the further constraint that the exposure must be as low as is reasonably achievable (10 CFR Part 20.01).

Part 20 also restricts the method of waste disposal (10 CFR Part 20.301-305). Disposal into a sanitary sewage system is not allowed unless:

- 1) the waste is readily soluble or dispersible in water,
- 2) the daily discharge is less than the larger of:
 - a) the quantity which if diluted by the average daily quantity of sewage would result in an average concentration equal to the unrestricted MPC in water, or
 - b) ten times the quantity of such material specified in Appendix C of 10 CFR Part 20,
- 3) the monthly average discharge concentration is below the unrestricted MPC in water, and
- 4) the gross discharge is less than 1 curie per year.

Burial of waste in soil is restricted by 10 CFR Part 20.304 to 12 burials per year or less at a minimum depth of 4 feet with successive burials separated by distances of at least 6 feet. The total quantity buried at any one location and time may not exceed, at the time of

burial, 1000 times the amount specified in Appendix C of 10 CFR Part 20.

The Appendix C values for several of the key isotopes are:

Cs-134	1 microcurie	Sr-90	0.1 microcurie
Cs-137	10 microcuries	Ra-226	0.01 microcurie
Co-60	1 microcurie		

Thus the inventory at any disposal location may be 1 millicurie of Co-60 or Cs-134 or 10 millicuries of Cs-137. Since for mixtures, the sum of the ratios of the quantity present to the inventory allowed must be less than or equal to one, the actual amounts of these isotopes allowed would be lower. For mixtures of beta emitters of unknown composition, the total inventory limit would be about 100 nanocuries.

There are no specific guidelines in 10 CFR Part 20 pertaining to disposal at sea or to incineration. They are handled on a case by case basis as provided for in Parts 20.302 and 20.305.

Federal Regulations, Title 10, Part 30

A person may receive, possess, use, transfer, own, or acquire materials containing byproduct radioactive material and be exempt from the requirements for a license providing the activity concentrations of byproduct material do not exceed those listed in 10 CFR Part 30.70 Schedule A (see 10 CFR Part 30.14). However, the introduction of byproduct material in exempt concentrations into materials and transfer of ownership or possession of it does require a license in accord with 10 CFR Part 32.11. Some limitations are stated in Part 32.11(c).

Federal Regulations, Title 10, Part 50 Appendix I

Appendix I to 10 CFR Part 50 provides numerical guides for reactor design objectives and limiting conditions of operation. The applicant

must provide reasonable assurance that the following design objectives will be met for each reactor. Total annual radioactive releases in liquid and gaseous effluents above background from a single light-water-cooled nuclear reactor must not cause the estimate of annual dose or dose commitment to any person in an unrestricted area to exceed:

- 1) 3 mrem to the total body or 10 mrem to any organ as a result of activity in liquid effluent,
- 2) 5 mrem to the total body or 15 mrem to the skin due to activity in gaseous effluent, and
- 3) 15 mrem to any organ from radioactive iodine and radioactive material in particulate form released to the atmosphere.

In addition to meeting these design objectives, the radwaste system must include all items of reasonably demonstrated technology, that when added to the system sequentially and in order of diminishing cost-benefit return, can for a favorable cost-benefit ratio effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. The interim value of \$1000 per total body man-rem and per man-thyroid-rem is currently accepted in the cost-benefit analysis.

Operating reactor guidelines are set at one-half of the design objective annual exposure based on actual releases in effluents during any calendar quarter. They represent design objectives for releases to the environment which are controlled and monitored prior to release and are the object of environmental monitoring after release.

These requirements apply to liquid and gaseous effluents of a single light water reactor, but they are not directly applicable to solid wastes. However, they do provide guidance in determining "de minimus" levels for solids.

Since "de minimus" wastes would not be subject to environmental surveillance after disposal, lower activity concentration limits in "de minimus" wastes than in reactor effluents may be justified, even though, in view of variations in natural radiation background levels, Appendix I design guides may be too low in the first place.

Federal Regulations, Title 10, Part 71

Because it is likely that "de minimus" waste will have to be transported, it is important to recognize the requirements of 10 CFR Part 71 for special packaging. Compliance may be guaranteed if the activity concentration is less than 2 nanocuries per gram or if each package contains less than 50 millicuries, the exempt quantity for mixed fission products. Assuming 50 millicuries are packaged in a 55-gallon drum at a density of 1.5 gram per cubic centimeter, the activity concentration could be as high as 160 nanocuries per gram. As will be shown later, this limitation is higher than that calculated herein as "de minimus."

Federal Regulations, Title 40, Part 190

The maximum annual exposure allowed by 40 CFR Part 190 to a member of the public as the result of planned discharges of radioactive material to the general environment from uranium fuel cycle operations is 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. These limitations exclude operations at waste disposal sites, but do not specifically exclude waste itself. However, the much lower limits of 40 CFR Part 190 make it clear that any attempt to use the exposure limits of 10 CFR Part 20 as a criterion for "de minimus" waste disposal will be unacceptable.

Proposed Federal Guidance on Transuranium Elements in the Environment

The Environmental Protection Agency has proposed Federal radiation protection guidance on limits of dose to persons exposed to transuranics in the environment as a result of existing or possible future unplanned contamination (EPA77). The text of the proposed guidance follows:

1. The annual alpha radiation dose rate to members of the critical segment of the exposed population as the result of exposure to transuranium elements in the general environment should not exceed either:
 - a. 1 millirad per year to the pulmonary lung, or and
 - b. 3 millirad per year to the bone.
2. For newly contaminated areas, control measures should be taken to minimize both residual levels and radiation exposures of the general public. The control measures are expected to result in levels well below those specified in paragraph one. Compliance with the guidance recommendations should be achieved within a reasonable period of time.
3. The recommendations are to be used only for guidance on possible remedial actions for the protection of the public health in instances of presently existing contamination or of possible future unplanned releases of transuranium elements. They are not to be used by Federal agencies as limits for planned releases of transuranium elements into the general environment.

One "millirad per year to the pulmonary lung" is meant to be the equilibrium dose rate resulting from chronic inhalation. The corresponding dose equivalent rate for alpha emitting transuranics is 20 millirem per year.

3.5 Selection of Dose Limits Appropriate for "de minimus" Disposal Concentrations

Concentrations of radionuclides which may be considered "de minimus" are directly related to dose limits which are appropriate for unrestricted disposal. That is, selection of such limits should be guided by criteria which reflect an acceptable level of health protection.

A rational conservative criterion for selecting "de minimus" dose limits is to select the level below which the dose rate to maximally exposed individuals is insignificant in comparison to the dose rate typically experienced by a member of the population from naturally occurring radiation and radioactivity. Considering the natural dose rate distribution in the USA, a few millirem per year more or less, ± 3 for instance, is not significant in comparison with the dose rate distribution from natural sources.

A practical criterion is that the dose limits selected must be compatible with existing radiation protection standards and regulations or must suggest appropriate revision of the regulations. To this end, practicality dictates the "de minimus" dose rate limit be no more than 10 CFR Part 50, Appendix I design objectives and possibly less. That is, to be consistent with existing regulations, the "de minimus" dose limit should not exceed 3 (liquid) to 5 (airborne) millirem total body dose equivalent per year to individual members of the public.

Practical guidance for selecting "de minimus" dose levels can be deduced from 10 CFR Part 20, Appendix B. According to Appendix B, footnote 5, a radionuclide in a mixture may be ignored if it is present

in less than 0.1 of its maximum permissible concentration and if the sum of the fractional MPC of all radionuclides considered as not present in the mixture does not exceed 0.25. A "de minimus" dose rate limit is then suggested by the combination of the Appendix I design objectives and the 0.25 factor of disregard given in 10 CFR Part 20, Appendix B. Together, 0.25 of 3 to 5 mrem per year total body dose is roughly one mrem per year. Consistent with 10 CFR Part 20, the corresponding individual organ dose limit would be 3 mrem per year. One millirem per year to the total body or 3 to individual organs is hardly significant in relation to doses received from natural background sources.

To further illustrate its insignificance, assuming the linear non-threshold dose-effect relation and the dose-to-risk estimates presented in the BEIR Report (BEIR72) hold at such a low dose rate, the additional risk associated with continuing doses of one mrem per year is estimated to be about one additional chance of adverse health effect in ten million person-years of exposure. It should be acknowledged that this extremely low estimate of hypothetical risk is probably an unrealistic overestimate of actual risk and may not be useful for other than illustration (see NC75a, pp. 3-4). Nevertheless, it is insignificant in relation to many demonstrated risks a typical resident experiences in the course of daily living in the US. By comparison, the US mortality rate in 1973 attributed to motor vehicles was 265 per million person-years and that attributed to falls was 80 per million person-years.

Therefore, one millirem per year total body dose equivalent and 3 millirem per year single organ dose equivalent in excess of the natural radiation background are suggested as dose equivalent rates at and below

which the dose rate to persons maximally exposed to radioactivity in solid waste should be acceptable as "de minimus." This radiation protection criterion was selected for use in connection with this study. If higher values than one millirem total body and 3 millirem to an organ are selected as "de minimus" dose limits, then the concentrations presented herein would be scaled upward directly.

Table 3-1

Summary of Representative Dose Equivalent
Rates in the USA from All Naturally Occurring Radiation Sources^a

Source	Dose Equivalent Rates (mrem/yr)				GI Tract
	Gonads	Lungs	Bone		
			Surfaces	Marrow	
Cosmic Radiation ^b	28	28	28	28	28
Cosmogenic Radionuclides	0.7	0.7	0.8	0.7	0.7
External Primordial Radionuclides ^b	26	26	26	26	26
Primordial Radionuclides in the Body	24	21	58	22	21
Inhaled Radionuclides ^c	—	106	—	—	—
	79	182	113	77	76

^a Adapted from NCRP Report No. 45, Table 44.

^b Indoor dose equivalent rates.

^c Doses to organs other than lung included in "Primordial Radionuclides in the Body."

4.0 METHODOLOGY EMPLOYED

In this study, solid wastes with very low activity concentrations are postulated to be placed in the environment with and without controls ordinarily imposed by regulations applicable to disposal of non-radioactive solid wastes. For voluminous solid material, land disposal is anticipated. One objective of this study was to develop a methodology to quantify the relation between the "de minimus" radiation protection criteria selected and the corresponding limiting concentration of each radionuclide in solid waste which allows the radiation protection criteria to be satisfied. The relation would be determined by environmental pathway analyses.

4.1 Disposal Scenarios

During the study, several disposal scenarios were considered with the objective of selecting those which are likely to have the most potential for maximum personal exposure to radioactive material in the environment from the discarded solid waste. Examination of potential environmental pathways and survey calculations suggested that land disposal with residents on the disposal site probably leads to the maximum hypothetical personal exposure. It should be noted that neither disposal at sea nor a disposal scenario that primarily produces airborne dispersion, e.g., incineration, was considered. Only the two scenarios which appear to have the most potential for maximum individual exposure were examined in detail. In one, identified as the "sanitary landfill" scenario, discard into a sanitary landfill with ordinary operating procedures in effect was postulated. Construction of a dwelling on the sanitary landfill was assumed to occur five years after operation of the sanitary landfill has

ended. In the other scenario, termed "fill wanted" disposal, unregulated use of the solid waste as landfill in a residential setting was postulated. In the latter case, a dwelling was assumed to exist on the landfill immediately after placement of the waste.

4.2 Environmental Pathways

An array of possible environmental pathways is associated with each disposal method. In this study, one requirement was to conceive feasible disposal scenarios with which the most important pathways are associated and to evaluate all of the associated pathways in a way which determines the critical pathway for each radionuclide in discarded waste.

The application of the methodology developed in this study was confined to land disposal of a homogeneous, bulk solid waste, namely spent, powdered ion exchange resins from PWR secondary systems.

Man's most direct radiation exposure from discarded solid waste could be by irradiation during or after its placement in a landfill. Ingestion of a small amount of waste or inhalation of material suspended in the air can also be direct pathways.

Other exposure pathways involve environmental transport mechanisms. Digging in a landfill may redistribute some of the material and cause some suspension in the air. If food crops are grown on a landfill that has not been covered adequately, plant uptake of radionuclides from the fill material may establish a link to man via vegetation and/or meat. Leaching followed by surface or ground water migration or erosion and transport by wind or water all create additional pathways to man where contact by external irradiation, ingestion, or inhalation are possible.

The evaluation of many environmental pathways is not heavily dependent upon site specific data. The evaluation of pathways involving hydrologic transport, namely groundwater migration or a surface stream is dependent on values of site related variables, however. To avoid site dependency, surface water and ground water migration were not modeled. Instead, a conservative choice of one percent of radioactivity in waste discarded was assumed to leach directly into a watercourse, per year. For dilution a stream flow of 10^4 liters per second was assumed. The effect of any other stream flow on estimated doses would be in inverse proportion to the nominal stream flow assumed.

Potential dose equivalent rates associated with the sanitary landfill and the fill wanted disposal scenarios were evaluated with environmental pathway models suggested in Regulatory Guide 1.109, Revision 0 (RG 1.109) except as mentioned for hydrologic pathways. Specific assumptions and values of variables assigned in the pathways evaluation are stated in Appendix B for each pathway examined in the "sanitary landfill" and "fill wanted" disposal schemes. Otherwise, values suggested in Regulatory Guide 1.109 for individuals were assigned. An example of specific assumptions, taken from Case I-A for the evaluation of postulated leaching of radionuclides from solids in a sanitary landfill to a watercourse is shown in Table 4-1. Detailed assumptions used in all the other cases and the computed results of the pathway analyses are included in Appendix B.

Bulk solid waste containing traces of radioactivity offers the most potential for individual exposure when used as landfill around a residence. Generally, the most direct exposure pathways were found to offer the greatest potential for exposure of persons nearby.

Ordinarily, radioactive material released as effluents is not assumed to perturb natural background exposure rates. However, bulk solids which, in isolation, contain "de minimus" concentrations of radioactivity, may actually reduce natural background exposure rates at the disposal location by shielding, displacing, or diluting the naturally radioactive environmental media (soil, etc.). Since the criterion selected for determining a "de minimus" concentration limit, i.e., natural background exposure rate plus an increment of one millirem/yr total body or 3 millirem/yr to any single organ, is so restrictive, perturbation of the natural background exposure rate at the disposal location may be a significant factor. For each millirem/yr reduction in natural background exposure rate caused by the presence of solid wastes, the contribution of the subject waste to the total exposure rate (from background plus waste) could conceptually be allowed to increase by one millirem/year without causing an environmental impact in excess of that corresponding to the criterion. Notwithstanding the likelihood that disposal of "de minimus" wastes may well result in a diminution of natural background radiation, no credit for this fact was taken in these calculations.

4.3 Calculational Technique

The general approach used to determine the "de minimus" concentrations was to first calculate the limiting radionuclide concentrations for each pathway separately. Then for every nuclide and pathway considered, a search of all pathways was conducted to find the pathway which resulted in the most restrictive disposal limitation for each radionuclide. These values represent the solution to the problem of determining "de minimus" concentrations.

A computer program was written to execute the above general procedure. Each pathway was represented by a subroutine which calculated the limiting concentrations for that pathway for the values assigned the variables. The limiting concentration was determined for each nuclide as if it were the only nuclide contributing to the dose rate with the exception that the dose rate associated with daughter products were charged against the parent nuclide. This was accomplished by assuming the initial concentration of each radionuclide in the waste was 1 pCi/g. Then for each pathway, the dose equivalent rate associated with each radionuclide and its accumulated decay products at the time of exposure was computed. Each computed dose equivalent rate and the associated activity concentration initially in the waste were scaled up or down to match the appropriate "de minimus" dose rate limit. In order to conservatively estimate doses, radioactive decay products were assumed to be transported with their parent in every pathway until taken into plants or animals. At that point, the stable element transfer data or bioaccumulation data in Regulatory Guide 1.109 were used where appropriate. Detailed equations used to evaluate each exposure pathway are given in Appendix A.

After the limiting concentrations for each pathway were calculated, the program selected the critical pathway of each nuclide. Finally, a table was generated, e.g., Table 4-3, which shows the limiting concentration for each critical pathway and the "de minimus" concentration limit with the associated most limiting pathway.

Figure 4-1 is a summary diagram of the method of determining the critical pathway and deriving the "de minimus" concentration limit of each radionuclide from among any postulated set of disposal scenarios and environmental pathways.

DO FOR EACH

radionuclide

Assign 1 pCi/g initial concentration
of each radionuclide in waste

disposal scenario
pathway
organ & total body
radionuclide

Compute dose equivalent commitment for
1 pCi nuclide/g waste (and its progeny
at time of exposure

disposal scenario
pathway
organ & total body
radionuclide

Compute "de minimus" concentration limit
$$\frac{\text{"de minimus" dose limit}}{\text{dose equiv of 1pCi/g waste}} \times \frac{\text{1pCi nuclide}}{\text{g waste}}$$

disposal scenario
pathway
organ & total body
radionuclide

Find pathway in which most restrictive
nuclide concentration exists, ie, find
the critical pathway

disposal scenario
pathway
organ & total body
radionuclide

List for each nuclide:
• pathways with maximum dose potential
• critical pathway
• "de minimus" concentration limit

Figure 4-1 Summary Diagram of Method of Determining
"de minimus" Radionuclide Concentration Limit

4.4 Results of Calculations

Individual Pathway Evaluation

Each disposal scenario-pathway-receptor (total body or organ) combination was computed independently to determine the "de minimus" concentration limit of each radionuclide in that case. Table 4-2 is an example of the results of calculations for one case, leaching from a sanitary landfill into a watercourse with a transit time of one year. Quantities assigned to environmental variables in the computer code are listed at the end of Table 4-2 and in Table 4-1.

A total of 143 separate disposal scenario-pathway-organ combinations were evaluated in four series of cases. They are identified by:

<u>Series</u>	<u>Disposal Scenario</u>	<u>Receptor of Dose</u>
I	Sanitary Landfill	Whole Body
II	Fill Wanted	Whole Body
III	Sanitary Landfill	Critical Organ
IV	Fill Wanted	Critical Organ

Computational results of 15 of these separate cases appear in Appendix B. In each of the tables, the limiting concentration of each radionuclide is expressed in units of microcurie per gram. Entries appearing as $1E07 \mu\text{Ci/gm}$ represent concentrations greater than $1 \times 10^7 \mu\text{Ci/gm}$ of waste. This value, equal to 10 Ci/gm , was chosen arbitrarily as an upper cutoff value.

Summary of Most Limiting Cases

After the limiting activity concentration of each radionuclide in each disposal scenario-pathway-receptor combination was calculated, the program selected the critical pathway of each radionuclide associated with any of the combinations evaluated. Finally, a table was generated,

e.g., Table 4-3, which shows the limiting concentration, i.e., the activity concentration of a radionuclide which may produce the "de minimus" dose limit, in each of the most important pathways associated with any of the disposal scenarios evaluated. The table also lists the "de minimus" concentration limit of each radionuclide along with its critical pathway. The tabulated values of the "de minimus" concentration limits, in Table 4-3 for instance, represent a general solution to the problem of determining "de minimus" concentrations based upon the most restrictive disposal scenarios and environmental pathways conceived.

The results shown in Table 4-3 are repeated in Table 4-4 but with the nuclides arranged in order of increasing "de minimus" concentration limit.

The lowest "de minimus" concentration limits is that of Ra-226, and its critical pathway is through a child eating some of the discarded resin. However, it is not a significant or limiting constituent of reactor wastes. The next most nearly limiting radionuclides, all of which have "de minimus" concentration limits below the pCi/gram level are:

<u>Nuclide</u>	<u>Limiting Pathway</u>
Co-60	Fill Wanted—Ground Exposure
Sr-90	Fill Wanted—Food Grown
Ag-110m	Fill Wanted—Ground Exposure
I-129	Fill Wanted—Food Grown

The "de minimus" concentration limits of every other radionuclide in reactor wastes is greater than 1 pCi/gram.

The use of the "fill wanted" scenario (Series II and IV) results in limits somewhat lower than would occur if it were assumed that the "de minimus" waste were disposed of in a sanitary landfill. If the

pathways to man are limited to those associated with disposal to a sanitary landfill, the activity concentration limits are shown in Table 4-5. The same values are shown in Table 4-6 except there the nuclides appear in order of increasing "de minimus" concentration limits.

Table 4-1

Quantities Assigned to Variables in the Evaluation of Postulated
Leaching of Radionuclides from a Sanitary Landfill to a Watercourse

Variable	Quantity	Basis
Maximum dose commitment	1 mrem/yr to adults	"de minimus" dose rate limit
Water ingestion rate	440 liters/yr	1.2 liters/day
Fish ingestion rate	21 kg/yr	Reg. Guide 1.109, max. exposed adult
Shellfish ingestion rate	5 kg/yr	Reg. Guide 1.109, max. exposed adult
Surface Watercourse flow	3×10^{14} cc/yr	Assigned by authors
Fresh Water	Bioaccumulation factors	Reg. Guide 1.109
Transport time, waste to consumption	1 year	Assigned by authors
Fraction of tritium leached from waste	1.0 in a year	Assume tritium is soluble
Fraction of other isotopes leached from waste	0.01 per yr	Assigned by authors
Disposal rate	$150 \text{ m}^3/\text{yr}$	Approximate production rate of spent powdered ion exchange resin/reactor
Duration of burial	10 years	Reasonable life of a sanitary landfill operation
Waste density	1.0 g/cm^3	Assigned density of bulk solid waste

TABLE 4-2

EXAMPLE OF COMPUTED CONCENTRATION LIMITS FOR
ONE DISPOSAL MODE-PATHWAY-RECEPTOR CASE
 CASE I-A -- SANITARY LANDFILL -
 LEACH INTO WATERCOURSE - TRANSIT TIME = 1 YEAR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	4.5E+00		
C---14	5.73E+03 YRS	2.5E-01		
NA--24	1.58E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.0E+07		
CR--51	2.78E+01 DYS	1.0E+07		
MN--54	3.12E+02 DYS	9.1E-01		
MN--56	2.58E+03 HRS	1.3E+07		
FE--55	2.40E+00 YRS	6.0E-01		
FE--59	4.50E+01 DYS	4.3E+03		
CO--58	7.10E+01 DYS	6.0E+03		
CO--60	5.24E+00 YRS	3.5E+00		
NI--59	9.01E+04 YRS	4.3E+00		
NI--63	9.21E+01 YRS	1.6E+00		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	9.2E-01		
ZN--69	5.50E+01 MIN	1.3E+07		
BR--83	2.40E+00 HRS	1.3E+07		
BR--84	3.20E+01 MIN	1.0E+07		
BR--85	3.00E+00 MIN	1.0E+07		
RB--86	1.87E+01 DYS	4.4E+06		
RB--88	1.80E+01 MIN	1.3E+07		
RR--89D	1.50E+01 MIN	1.0E+07	SR--89	100.
SR--89	5.06E+01 DYS	1.1E+04		
SR--90	2.88E+01 YRS	7.9E-03		
SR--91D	9.70E+00 HRS	1.0E+07	Y---91	100.
SR--92	2.70E+00 HRS	1.0E+07		
Y---90	2.67E+00 DYS	1.0E+07		
Y--91M0	5.00E+01 MIN	1.0E+07	Y---91	100.
Y---91	5.90E+01 DYS	2.8E+06		
Y---92	3.53E+00 HRS	1.3E+07		
Y---93D	1.62E+01 HRS	1.0E+07	NB-93M	100.
ZR--93D	1.50E+06 YRS	2.6E+01	NB-93M	100.
ZR--95D	6.50E+01 DYS	2.1E+04	NB--95	100.
ZR--97+0	1.70E+01 HRS	1.0E+07	NB--97	97.
NR-93F	3.70E+00 YRS	4.1E+01		
NB--95	3.50E+01 DYS	2.3E+06		
NB--97	1.20E+00 HRS	1.0E+07		
NO--99D	2.79E+00 DYS	1.0E+07	TC--99	100.
TC-99M0	6.00E+00 HRS	1.0E+07	TC--99	100.
TC--99	2.10E+05 YRS	5.1E+02		
RU-103	4.00E+01 DYS	4.1E+06		
RU-105D	4.43E+00 HRS	1.0E+07	RH-105	100.
RU-106	1.00E+00 YRS	3.7E+02		
RH-105	1.50E+00 DYS	1.0E+07		
AG110M	2.60E+02 DYS	1.3E+03		
TE125M	5.80E+01 DYS	4.8E+03		
TE127M+0	1.05E+02 DYS	1.6E+02	TE-127	3.
TE-127	9.30E+00 HRS	1.0E+07		
TE129M	3.40E+01 DYS	3.5E+04		

TABLE 4-2 (contd)

EXAMPLE OF COMPUTED CONCENTRATION LIMITS FOR
ONE DISPOSAL MODE-PATHWAY-RECEPTOR CASE

CASE I-A -- SANITARY LANDFILL -

LEACH INTO WATERCOURSE - TRANSIT TIME = 1 YEAR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+00 HRS	1.3E+07	I--129	100.
TE-131MC	1.20E+00 DYS	1.0E+07	I--131	100.
TE-131D	2.50E+01 MIN	1.0E+07	I--131	100.
TE-132	3.25E+00 DYS	1.3E+07		
I--129	1.60E+07 YRS	2.0E+06		
I--130	1.24E+01 HRS	1.0E+07		
I--131	0.05E+00 DYS	1.3E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	1.0E+07	CS-135	100.
CS-134	2.13E+00 YRS	1.0E-02		
CS-135	2.00E+06 YRS	5.0E-02		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137	3.00E+01 YRS	7.5E-03		
CS-138	3.22E+01 MIN	1.0E+07		
BA-140	1.20E+01 DYS	1.3E+07		
BA-141C	1.00E+01 MIN	1.0E+07	CE-141	100.
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-141D	3.90E+00 HRS	1.0E+07	CE-141	100.
LA-142	1.40E+01 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143D	1.37E+00 DYS	1.0E+07	PR-143	100.
CE-144	2.05E+02 DYS	3.0E+03		
PR-143	1.37E+01 DYS	1.0E+07		
PR-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	3.7E+05	PM-147	100.
PM-147	2.60E+00 YRS	4.0E+03		
M--187	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	3.3E-05		
AC-227+D	2.16E+01 YRS	7.2E-03	RA-223	80.
TH-227D	1.02E+01 DYS	4.1E+05	RA-223	100.
PA-231+D	3.25E+04 YRS	2.6E-02	RA-223	59.
U--235	7.13E+08 YRS	5.3E-01		
NP-239D	2.35E+00 DYS	4.0E+06	PU-239	100.
PU-239	2.44E+04 YRS	1.3E+00		

BASED ON: LEACHING OF WASTE INTO WATERCOURSE

A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR TO ADULTS

CONSUMPTION RATE OF WATER = 40.0 LITERS/YEAR

CONSUMPTION RATE OF FISH = 21.0 KG/YEAR

CONSUMPTION RATE OF SHELLFISH = 5.0 KG/YEAR

DILUTION FLOW RATE = 3.0E+14 CC/YEAR

FRESH WATER

TRANSPORT TIME FROM WASTE TO CONSUMPTION = 1.0E+00 YEARS

FRACTION OF TRITIUM LEACHED FROM WASTE = 1.0E+00 PER YEAR

FRACTION OF OTHER ISOTOPES LEACHED FROM WASTE 1.0E-02 PER YEAR

BURIAL RATE = 1.5E+02 CUBIC METERS PER YEAR

DURATION OF BURIAL = 10.0 YEARS

WASTE DENSITY = 1.0 GM/CC

TABLE 4-3
MOST RESTRICTIVE CONCENTRATION LIMITS AND DISPOSAL-PATHWAY-RECEPTOR
COMBINATIONS SELECTED FROM ALL COMPUTED CASES
 CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	LIMIT CONCEN														
H---3	61	3.E-15	62	4.E-05	63	6.E-15	29	7.E-05	30	9.E-05	129	1.E-64	131	2.E-04	130	1.E-04
C---14	129	4.E-36	130	4.E-06	131	4.E-06	132	4.E-66	133	4.E-06	112	5.F-66	113	5.E-06	114	6.E-06
HA--24	41	3.E-26	42	4.E-06	46	8.E-06	47	1.E-05	76	4.E-05	77	6.E-05	43	2.E-04	48	5.E-04
P---32	76	5.E-05	77	5.E-05	46	5.E-05	47	5.E-05	78	5.E-05	48	6.E-65	41	2.E-64	42	2.E-64
CO--51	76	1.E-64	77	1.E-64	78	1.E-64	46	2.E-04	47	2.E-04	48	2.E-04	41	2.E-64	42	2.E-64
MN--54	76	2.E-06	77	2.E-06	78	2.E-06	79	3.E-66	80	5.E-66	46	9.E-06	47	9.E-06	48	9.E-06
MN--56	41	6.E-76	42	6.E-05	46	1.E-04	76	5.E-04	47	1.E-03	77	5.E-63	125	4.E-01	124	4.E-02
FF--55	129	5.E-73	124	5.E-03	125	5.E-03	126	5.E-03	127	5.E-03	130	5.E-63	128	6.E-03	61	7.E-63
FE--59	76	3.E-6	77	3.E-06	78	3.E-06	79	5.E-06	46	6.E-06	47	7.E-06	48	7.E-06	41	9.E-06
CO--54	76	3.E-6	77	3.E-06	78	3.E-06	79	4.E-06	46	7.E-06	47	7.E-06	48	7.E-06	41	9.E-06
CO--60	76	8.E-07	77	8.E-07	78	8.E-07	79	8.E-07	80	9.E-07	52	9.E-67	81	3.E-06	53	2.E-06
NI--59	129	4.E-74	130	4.E-04	131	4.E-04	132	4.E-04	133	4.E-04	112	6.E-04	113	6.E-04	114	6.E-04
NI--63	129	3.E-05	130	3.E-05	131	3.E-05	112	5.E-05	113	5.E-05	132	6.E-05	114	1.E-04	61	3.E-04
NI--65	124	9.E-02	125	9.E-01	56	2.E-04	57	2.E-01	134	3.E-03	135	4.E-04	66	6.E-04	96	1.E-05
CU--64	41	4.E-05	42	6.E-05	46	2.E-04	47	2.E-04	76	9.E-04	77	1.E-03	43	4.E-03	48	2.E-02
ZN--65	76	4.E-06	77	4.E-06	78	4.E-06	79	4.E-06	61	6.E-06	129	9.E-06	96	1.E-05	62	1.E-05
ZN--69	41	7.F-04	46	6.E-03	76	3.E-02	42	5.E-01	47	5.E-06	124	8.E-06	77	2.E-01	56	4.E-01
GF--83	41	4.E-04	46	2.E-03	42	6.E-03	76	1.E-02	47	3.E-02	77	1.E-01	124	3.E-00	56	1.E-06
RG--84	41	5.E-06	46	4.E-04	76	2.E-03	42	4.E-01	56	1.E-06	124	3.E-06	47	3.E-01	77	2.E-02
SE--85	41	8.E-15	46	2.E-02	42	2.E-02	76	8.E-02	47	2.E-01	77	1.E-00	56	2.E-01	52	4.E-01
RG--86	76	2.E-05	77	2.E-05	78	2.E-05	46	3.E-05	47	3.E-05	48	3.E-05	41	7.E-05	42	7.E-05
RA--88	41	1.F-05	46	1.E-03	76	6.E-03	56	2.E-00	124	3.E-00	66	4.E-03	134	6.E-03	42	7.E-03
RG--89	41	5.E-06	46	8.E-04	76	4.E-03	77	8.E-02	78	8.E-02	79	1.E-01	47	2.E-01	48	2.E-01
SP--89	76	2.E-05	77	2.E-05	78	2.E-05	79	3.E-05	46	4.E-05	47	4.E-05	48	4.E-05	49	8.E-05
SR--90	129	4.E-7	130	8.E-07	131	9.E-07	61	1.E-06	62	1.E-06	63	1.E-06	112	2.E-06	113	2.E-06
SC--91	41	1.F-05	42	1.E-05	46	4.E-05	47	7.E-05	76	2.E-04	77	3.E-04	78	3.E-03	43	4.E-03
SR--92	41	4.E-06	42	4.E-05	46	8.E-05	47	4.E-04	76	4.E-04	77	2.E-03	125	2.E-02	124	4.E-03
Y---96	46	3.E-05	47	4.E-05	48	4.E-05	41	1.E-04	42	1.E-04	76	1.E-04	77	1.E-04	43	3.E-04
Y---91M	41	1.F-05	46	8.E-04	76	4.E-03	42	2.E-02	77	3.E-02	78	3.E-02	79	5.E-02	47	8.E-02
Y---91	76	2.E-05	77	2.E-05	78	2.E-05	79	3.E-05	46	5.E-05	47	5.E-05	48	5.E-05	49	8.E-05
Y---02	41	2.E-05	42	1.E-04	46	2.E-04	76	9.E-04	47	1.E-03	77	5.E-03	125	6.E-02	124	1.E-02
Y---93	41	3.F-05	42	6.E-05	46	9.E-05	47	1.E-04	76	4.E-04	77	7.E-04	125	3.E-03	124	2.E-03
ZP--93	54	2.F-05	55	2.E-05	53	2.E-05	52	3.E-05	92	4.E-05	93	4.E-05	91	4.E-05	51	2.E-04
ZP--95	76	2.E-06	77	2.E-06	78	2.E-06	79	2.E-06	49	8.E-06	48	8.E-06	47	9.E-06	46	9.E-06
ZP--97	42	8.E-06	46	1.E-05	47	2.E-05	41	5.E-05	76	7.E-05	77	1.E-04	43	2.E-04	48	5.E-04
NR-93M	76	3.E-05	77	3.E-05	78	3.E-05	79	4.E-05	80	4.E-05	52	5.E-05	46	1.E-04	47	1.E-04
NR--95	76	4.E-06	77	5.E-06	78	5.E-06	46	9.E-06	47	9.E-06	79	9.E-06	48	1.E-05	41	1.E-05
NR--07	41	1.E-05	46	4.E-04	42	2.E-03	76	2.E-03	47	7.E-02	77	4.E-01	125	5.E-02	124	3.E-00
MO--99	46	3.E-05	47	4.E-05	42	5.E-05	41	6.E-05	48	8.E-05	43	9.E-05	77	1.E-04	76	1.E-04
TC-99M	41	9.E-05	42	2.E-04	46	8.E-04	47	2.E-03	76	4.E-03	77	1.E-02	125	1.E-00	124	4.E-01
TC--99	129	2.E-05	130	2.E-05	131	2.E-05	132	2.E-05	133	2.E-05	112	3.E-05	113	3.E-05	114	3.E-05
QU-103	76	6.F-06	77	6.E-06	78	6.E-06	79	1.E-05	46	1.E-05	47	1.E-05	48	1.E-05	41	2.E-05
RU-105	41	1.E-05	42	4.E-05	46	1.E-04	47	3.E-04	76	5.E-04	77	2.E-03	43	3.E-03	48	5.E-03
RU-106	76	2.E-06	77	2.E-06	78	2.E-06	79	3.E-06	80	5.E-06	129	6.E-06	46	9.E-06	47	9.E-06
RH-105	41	3.E-05	42	1.E-04	46	1.E-04	47	1.E-04	43	5.E-04	76	5.E-04	77	6.E-04	48	6.E-04

TABLE 4-3 (contd)

CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS LIMIT		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN
AG-110M	75	4.E-17	77	4.E-07	78	8.E-07	79	8.E-07	80	2.E-06	46	3.E-06	47	3.E-16	48	3.E-06
TE-125M	129	5.E-15	130	4.E-04	61	5.E-04	76	7.E-04	77	7.E-04	78	8.E-04	79	1.E-03	46	2.E-03
TE-127M	129	5.E-16	130	2.E-05	76	4.E-05	77	4.E-05	78	4.E-05	79	5.E-05	61	8.E-05	47	1.E-04
TE-127	46	3.E-04	41	1.E-03	47	2.E-03	42	2.E-03	76	5.E-03	124	8.E-03	125	2.E-02	77	9.E-03
TE-129M	75	1.E-05	77	1.E-05	78	1.E-05	46	2.E-05	47	2.E-05	79	2.E-05	129	4.E-05	48	3.E-05
TE-129	41	6.E-05	46	2.E-03	76	4.E-03	42	2.E-02	47	4.E-01	124	1.E-01	77	2.E-01	56	7.E-01
TE-131M	41	8.E-06	42	9.E-06	46	1.E-05	47	2.E-05	43	5.E-05	76	5.E-05	77	6.E-05	48	7.E-05
TE-131	41	2.E-05	46	2.E-03	76	6.E-03	47	9.E-03	42	1.E-02	48	1.E-02	77	1.E-02	43	1.E-02
TE-132	46	4.E-06	47	4.E-06	42	4.E-06	43	7.E-06	48	9.E-06	76	1.E-05	78	2.E-05	77	1.E-05
I--129	129	5.E-07	130	5.E-07	131	5.E-07	132	5.E-07	133	5.E-07	112	9.E-07	113	9.E-07	114	9.E-07
I--130	41	4.E-06	42	6.E-06	46	2.E-05	47	3.E-05	76	3.E-05	77	3.E-05	124	5.E-04	43	5.E-04
I--131	46	2.E-05	47	2.E-05	41	2.E-05	42	2.E-05	48	3.E-05	76	3.E-05	124	3.E-05	77	3.E-05
I--132	41	4.E-06	42	5.E-05	46	9.E-05	76	4.E-04	47	1.E-03	124	2.E-03	125	3.E-02	77	6.E-03
I--133	41	2.E-05	42	2.E-05	46	3.E-05	47	5.E-05	124	3.E-05	125	1.E-04	76	2.E-04	77	2.E-04
I--134	41	5.E-06	46	3.E-04	76	1.E-03	124	4.E-03	42	5.E-03	47	3.E-03	56	5.E-03	77	1.E-03
I--135	41	6.E-06	42	1.E-05	46	3.E-05	47	7.E-05	76	2.E-04	77	4.E-04	125	2.E-03	424	1.E-03
CS-134	76	1.E-06	77	1.E-06	78	1.E-06	79	1.E-06	80	1.E-06	52	3.E-06	46	4.E-06	47	4.E-06
CS-135	52	2.E-04	53	2.E-04	54	2.E-04	55	2.E-04	61	3.E-04	62	3.E-04	64	3.E-04	63	3.E-04
CS-136	46	4.E-06	47	4.E-06	76	4.E-06	77	4.E-06	48	5.E-06	41	5.E-06	78	5.E-06	42	5.E-06
CS-137	52	2.E-06	53	2.E-06	76	2.E-06	77	2.E-06	78	2.E-06	79	2.E-06	41	3.E-06	81	2.E-06
CS-138	41	5.E-06	46	4.E-04	76	2.E-03	42	4.E-01	56	9.E-01	124	1.E-01	47	3.E-01	77	2.E-02
GA-140	76	3.E-06	77	3.E-06	78	4.E-06	48	4.E-06	47	5.E-06	46	5.E-06	43	6.E-06	42	2.E-05
GA-141	41	2.E-05	46	1.E-03	42	4.E-03	76	7.E-03	47	2.E-02	77	5.E-02	78	1.E-01	48	3.E-01
GA-142	41	2.E-05	46	9.E-04	42	3.E-03	76	4.E-03	47	7.E-02	77	4.E-01	125	2.E-02	124	7.E-01
LA-140	41	5.E-06	42	6.E-06	46	7.E-06	47	8.E-06	43	2.E-05	76	3.E-05	77	3.E-05	48	3.E-05
LA-141	46	3.E-05	46	3.E-04	42	4.E-04	47	1.E-03	76	1.E-03	77	4.E-03	124	1.E-02	78	1.E-02
LA-142	41	5.E-06	46	2.E-04	42	4.E-04	76	7.E-04	47	1.E-02	77	6.E-02	125	3.E-01	124	4.E-01
CE-141	76	5.E-05	77	5.E-05	78	5.E-05	46	9.E-05	47	9.E-05	48	1.E-04	79	1.E-04	41	2.E-04
CF-143	46	3.E-05	41	3.E-05	47	3.E-05	42	3.E-05	76	4.E-05	77	4.E-05	78	5.E-05	48	5.E-05
CE-144	76	4.E-06	77	4.E-06	78	4.E-06	79	4.E-06	80	4.E-06	46	1.E-05	47	1.E-05	48	1.E-05
DF-143	76	5.E-06	46	5.E-06	77	5.E-06	47	5.E-06	79	5.E-06	49	6.E-06	41	1.E-05	42	1.E-05
DF-144	41	5.E-05	46	3.E-03	76	2.E-02	124	5.E-03	56	3.E-04	42	7.E-04	139	3.E-06	96	1.E-06
NP-147	46	4.E-05	47	4.E-05	76	4.E-05	77	4.E-05	48	5.E-05	78	5.E-05	41	6.E-05	42	6.E-05
PM-147	76	3.E-04	77	3.E-04	78	3.E-04	79	3.E-04	80	3.E-04	52	6.E-04	46	1.E-03	47	1.E-03
W--147	41	2.E-05	42	2.E-05	46	4.E-05	47	5.E-05	76	2.E-04	43	2.E-04	77	2.E-04	48	5.E-04
RA-223	124	3.E-05	125	3.E-05	126	4.E-05	56	5.E-05	57	5.E-05	58	6.E-05	127	3.E-04	59	5.E-04
RA-226	24	2.E-07	26	2.E-07	56	2.E-07	57	2.E-07	58	2.E-07	59	2.E-07	61	2.E-07	27	2.E-07
AC-227	129	1.E-05	130	1.E-05	131	1.E-05	112	2.E-05	128	2.E-05	108	2.E-05	113	3.E-05	109	3.E-05
TH-227	127	4.E-05	126	1.E-04	59	1.E-04	125	2.E-04	58	3.E-04	124	3.E-04	129	1.E-02	57	2.E-03
PA-231	132	4.E-06	113	4.E-06	131	6.E-06	130	7.E-06	129	7.E-06	114	8.E-06	115	8.E-06	113	1.E-05
U--235	129	5.E-05	130	5.E-05	131	5.E-05	132	5.E-05	133	5.E-05	112	1.E-04	113	1.E-04	114	1.E-04
NP-239	124	6.E-03	125	7.E-03	126	2.E-02	127	2.E-02	104	2.E-02	105	2.E-02	106	2.E-02	107	2.E-02
PU-239	104	5.E-05	105	5.E-05	106	5.E-05	107	5.E-05	108	5.E-05	109	5.E-05	125	1.E-04	124	1.E-04

TABLE 4-3 (contd)

CONCENTRATION LIMITS (UCI/GM)

TABLE 25	- CASE I-E --	SANITARY LANDFILL -	CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE 26	- CASE I-E --	SANITARY LANDFILL -	CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE 27	- CASE I-E --	SANITARY LANDFILL -	CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE 29	- CASE I-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE 30	- CASE I-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE 41	- CASE I-I --	SANITARY LANDFILL -	EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE 42	- CASE I-I --	SANITARY LANDFILL -	EXPOSURE TO 55 GALLON DRUMS AFTER 0.01 YEARS
TABLE 43	- CASE I-I --	SANITARY LANDFILL -	EXPOSURE TO 55 GALLON DRUMS AFTER 0.01 YEARS
TABLE 46	- CASE I-J --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY
TABLE 47	- CASE I-J --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR
TABLE 48	- CASE I-J --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR
TABLE 49	- CASE I-J --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.1 YRS
TABLE 51	- CASE I-J --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO WORKERS AFTER 10 YRS
TABLE 52	- CASE I-K --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE 53	- CASE I-K --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 10 YR
TABLE 54	- CASE I-K --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 Y
TABLE 55	- CASE I-K --	SANITARY LANDFILL -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 103 Y
TABLE 56	- CASE II-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER NO DECAY
TABLE 57	- CASE II-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.001 YEARS DECAY
TABLE 58	- CASE II-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.01 YEARS DECAY
TABLE 59	- CASE II-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 60	- CASE II-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE 1 YEAR DECAY
TABLE 61	- CASE II-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
TABLE 62	- CASE II-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 1 YEAR DECAY
TABLE 63	- CASE II-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 10 YEARS DECAY
TABLE 64	- CASE II-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 100 YEARS DECAY
TABLE 66	- CASE II-G --	FILL WANTED DISPOSAL -	EROSION INTO WATER COURSE AFTER NO DECAY
TABLE 76	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY
TABLE 77	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 0.001 YRS
TABLE 78	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 0.01 YEARS
TABLE 79	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 0.1 YEARS
TABLE 80	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 1 YEAR
TABLE 81	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 10 YEARS
TABLE 82	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 YEARS
TABLE 83	- CASE II-K --	FILL WANTED -	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 1000 YEARS
TABLE 86	- CASE III-C --	SANITARY LANDFILL -	INHALATION SPILLED WASTE AFTER NO DECAY
TABLE 104	- CASE III-D --	SANITARY LANDFILL -	INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE 105	- CASE III-D --	SANITARY LANDFILL -	INHALATION DURING SITE EXCAVATION AFTER 10 YRS
TABLE 106	- CASE III-D --	SANITARY LANDFILL -	INHALATION DURING SITE EXCAVATION AFTER 100 YR
TABLE 107	- CASE III-D --	SANITARY LANDFILL -	INHALATION DURING SITE EXCAVATION AFTER 1000 Y
TABLE 108	- CASE III-E --	SANITARY LANDFILL -	CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE 109	- CASE III-E --	SANITARY LANDFILL -	CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE 112	- CASE III-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE 113	- CASE III-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE 114	- CASE III-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE 115	- CASE III-F --	SANITARY LANDFILL -	FOOD GROWN ON WASTE SITE AFTER 1000 YEARS
TABLE 124	- CASE IV-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER NO DECAY
TABLE 125	- CASE IV-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.001 YEARS DECAY
TABLE 126	- CASE IV-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.01 YEARS DECAY
TABLE 127	- CASE IV-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 128	- CASE IV-E --	FILL WANTED DISPOSAL -	CHILD EATS WASTE AFTER 1 YEAR DECAY
TABLE 129	- CASE IV-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
TABLE 130	- CASE IV-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 1 YEAR DECAY
TABLE 131	- CASE IV-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 10 YEARS DECAY
TABLE 132	- CASE IV-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 100 YEARS DECAY
TABLE 133	- CASE IV-F --	FILL WANTED DISPOSAL -	FOOD GROWN IN WASTE AFTER 1000 YEARS DECAY
TABLE 134	- CASE IV-G --	FILL WANTED DISPOSAL -	EROSION INTO WATERCOURSE AFTER NO DECAY
TABLE 135	- CASE IV-G --	FILL WANTED DISPOSAL -	EROSION INTO WATERCOURSE AFTER 0.001 YEARS
TABLE 139	- CASE IV-H --	FILL WANTED DISPOSAL -	INHALATION OF WASTE ERODED AFTER NO DECAY

TABLE 4-4

**MOST RESTRICTIVE CONCENTRATION LIMITS AND
DISPOSAL-PATHWAY-RECEPTOR COMBINATIONS SELECTED
FROM ALL COMPUTED CASES ARRANGED BY INCREASING
"DE MINIMUS" CONCENTRATION LIMIT
CONCENTRATION LIMITS (UCI/GM)**

NUCLIDE	DE MINIMUS LIMIT		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN
RA-226	25	2.E-07	26	2.E-07	56	2.E-07	57	2.E-07	58	2.E-07	59	2.E-07	66	2.E-07	27	2.E-07
I--129	129	5.E-07	130	5.E-07	131	5.E-07	132	5.E-07	133	5.E-07	112	9.E-07	113	9.E-07	114	9.E-07
SR--96	129	8.E-07	130	8.E-07	131	9.E-07	61	1.E-06	62	1.E-06	63	1.E-06	112	2.E-06	113	2.E-06
AG110M	76	8.E-07	77	8.E-07	78	8.E-07	79	8.E-07	80	2.E-06	46	3.E-06	47	3.E-06	48	3.E-06
CO--60	76	8.E-07	77	8.E-07	78	8.E-07	79	8.E-07	80	9.E-07	52	9.E-07	81	3.E-06	53	2.E-06
CS-134	76	1.E-06	77	1.E-06	78	1.E-06	79	1.E-06	80	1.E-06	52	3.E-06	46	4.E-06	47	4.E-06
CS-137	52	2.E-06	53	2.E-06	76	2.E-06	77	2.E-06	78	2.E-06	79	2.E-06	81	3.E-06	80	2.E-06
ZF--95	76	2.E-06	77	2.E-06	78	2.E-06	79	2.E-06	49	8.E-06	48	8.E-06	47	9.E-06	46	9.E-06
HN--54	76	2.E-06	77	2.E-06	78	2.E-06	79	3.E-06	80	5.E-06	46	9.E-06	47	9.E-06	48	9.E-06
RU-106	76	2.E-06	77	2.E-06	78	2.E-06	79	3.E-06	80	5.E-06	129	8.E-06	46	9.E-06	47	9.E-06
CO--58	76	3.E-06	77	3.E-06	78	3.E-06	79	4.E-06	46	7.E-06	47	7.E-06	48	7.E-06	41	9.E-06
FF--59	76	3.E-06	77	3.E-06	78	3.E-06	79	5.E-06	46	6.E-06	47	7.E-06	48	7.E-06	41	9.E-06
NA--24	41	3.E-06	42	4.E-06	46	8.E-06	47	1.E-05	76	4.E-05	77	8.E-05	43	2.E-04	48	5.E-04
HA-140	76	3.E-06	77	3.E-06	78	4.E-06	48	4.E-06	47	5.E-06	46	5.E-06	43	6.E-06	42	2.E-05
YN--65	76	4.E-06	77	4.E-06	78	4.E-06	79	4.E-06	61	6.E-06	129	9.E-06	46	1.E-05	62	1.E-05
CF-144	76	4.E-06	77	4.E-06	78	4.E-06	79	4.E-06	81	9.E-06	46	1.E-05	47	1.E-05	48	1.E-05
C--14	129	4.E-06	130	4.E-06	131	4.E-06	132	4.E-06	133	4.E-06	112	5.E-06	113	5.E-06	114	6.E-06
TE-132	46	4.E-06	47	4.E-06	42	4.E-06	43	7.E-06	44	8.E-06	76	1.E-05	78	2.E-05	77	1.E-05
I--132	41	4.E-06	42	5.E-05	46	8.E-05	76	4.E-04	47	1.E-03	124	2.E-03	125	3.E-02	77	6.E-03
CS-136	46	4.E-06	47	4.E-06	76	4.E-06	77	4.E-06	48	5.E-06	41	5.E-06	78	5.E-06	42	5.E-06
I--130	41	4.E-06	42	6.E-06	46	2.E-05	47	3.E-05	76	4.E-05	77	1.E-04	124	5.E-04	43	5.E-04
PA-231	132	4.E-06	133	4.E-06	131	6.E-06	130	7.E-06	129	7.E-06	114	8.E-06	115	8.E-06	113	1.E-05
NA--95	76	4.E-06	77	5.E-06	78	5.E-06	46	9.E-06	47	9.E-06	79	9.E-06	48	1.E-05	41	1.E-05
R9--89	41	5.E-06	46	9.E-04	76	4.E-03	77	8.E-02	78	9.E-02	79	1.E-01	47	2.E-01	48	2.E-01
CS-138	41	5.E-06	46	4.E-04	76	2.E-03	42	4.E-01	56	9.E-01	124	1.E-01	47	3.E-01	77	2.E-02
PO-143	76	5.E-06	46	5.E-06	77	5.E-06	47	5.E-06	78	6.E-06	48	6.E-06	41	1.E-05	42	1.E-05
9F--84	41	5.E-06	46	4.E-04	76	2.E-03	42	4.E-01	56	1.E-01	124	3.E-01	47	3.E-01	77	2.E-02
I--134	41	5.E-06	46	3.E-04	76	1.E-03	124	4.E-03	42	5.E-03	47	3.E-01	56	5.E-01	77	1.E-01
LA-140	41	5.E-06	42	6.E-06	46	7.E-06	47	8.E-06	43	2.E-05	76	3.E-05	77	3.E-05	48	3.E-05
LA-142	41	5.E-06	46	2.E-04	42	4.E-04	76	7.E-04	47	1.E-02	77	6.E-02	125	3.E-01	124	4.E-01
TE127M	129	5.E-06	130	2.E-05	76	4.E-05	77	4.E-05	79	4.E-05	79	5.E-05	61	8.E-05	47	1.E-04
RU-103	76	6.E-06	77	6.E-06	78	6.E-06	79	1.E-05	46	1.E-05	47	1.E-05	48	1.E-05	41	2.E-05
YN--56	41	6.E-06	42	6.E-05	46	1.E-04	76	5.E-04	47	1.E-03	77	5.E-03	125	4.E-01	124	4.E-02
I--135	41	8.E-06	42	1.E-05	46	3.E-05	47	7.E-05	76	2.E-04	77	4.E-04	125	2.E-03	124	1.E-03
ZR--97	42	8.E-06	46	1.E-05	47	2.E-05	41	5.E-05	76	7.E-05	77	1.E-04	43	2.E-04	48	5.E-04
SP--92	41	9.E-06	42	4.E-05	46	8.E-05	47	4.E-04	76	4.E-04	77	2.E-03	125	2.E-02	124	4.E-03
TE131M	41	8.E-06	42	9.E-06	46	1.E-05	47	2.E-05	43	5.E-05	76	5.E-05	77	6.E-05	48	7.E-05
AC-227	129	1.E-05	130	1.E-05	131	1.E-05	112	2.E-05	128	2.E-05	118	2.E-05	113	3.E-05	109	3.E-05
FR--88	41	1.E-05	46	1.E-03	76	6.E-03	56	2.E-00	124	3.E-00	66	4.E-03	134	6.E-03	42	7.E-03
TE129M	76	1.E-05	77	1.E-05	78	1.E-05	46	2.E-05	47	2.E-05	79	2.E-05	129	4.E-05	48	3.E-05
NR--97	41	1.E-05	46	4.E-04	42	2.E-03	76	2.E-03	47	7.E-02	77	4.E-01	125	5.E-02	124	3.E-00
RU-105	41	1.E-05	42	4.E-05	46	1.E-04	47	3.E-04	76	5.E-04	77	2.E-03	43	3.E-03	48	5.E-03
SR--91	41	1.E-05	42	1.E-05	46	4.E-05	47	7.E-05	76	2.E-04	77	3.E-04	78	3.E-03	43	4.E-03
Y--91M	41	1.E-05	46	8.E-04	76	4.E-03	42	2.E-02	77	3.E-02	78	3.E-02	79	5.E-02	47	8.E-02
I--133	41	2.E-05	42	2.E-05	46	3.E-05	47	5.E-05	124	8.E-05	125	1.E-04	76	2.E-04	77	2.E-04

TABLE 4-4 (contd)

CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS LIMIT		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN
SP--89	76	2.E-05	77	2.E-05	78	2.E-05	79	3.E-05	46	4.E-05	47	4.E-05	48	4.E-05	49	7.E-05
PA-142	41	2.E-05	46	9.E-04	42	3.E-03	76	4.E-03	47	7.E-02	77	4.E-01	125	2.E+02	124	7.E+06
TC--99	129	2.E-15	136	2.E-15	131	2.E-05	132	2.E-05	133	2.E-05	112	3.E-05	113	3.E-05	114	3.E-05
I--131	46	2.E-05	47	2.E-05	41	2.E-05	42	2.E-05	48	3.E-05	76	3.E-05	124	3.E-05	77	3.E-05
QA-141	41	2.E-05	46	1.E-03	42	4.E-03	76	7.E-03	47	2.E-02	77	5.E-02	78	1.E-01	48	3.E-01
QA--86	76	2.E-05	77	2.E-05	78	2.E-05	46	3.E-05	47	3.E-05	48	3.E-05	41	7.E-15	42	7.E-05
Y--91	76	2.E-05	77	2.E-05	78	2.E-05	79	3.E-05	46	5.E-05	47	5.E-05	48	5.E-05	49	8.E-05
M--147	41	2.E-05	42	2.E-05	46	4.E-05	47	5.E-05	76	2.E-04	43	2.E-04	77	2.E-04	48	5.E-04
TA--93	54	2.E-05	55	2.E-05	53	2.E-05	52	3.E-05	82	4.E-05	43	4.E-05	81	4.E-05	51	2.E-04
Y--131	41	2.E-05	46	2.E-03	76	6.E-03	47	9.E-03	42	1.E-02	48	1.E-02	77	1.E-02	43	1.E-02
Y--92	41	2.E-05	42	1.E-04	46	2.E-04	76	9.E-04	47	1.E-03	77	5.E-03	125	6.E-02	124	1.E-02
CE-143	46	3.E-05	41	3.E-05	47	3.E-05	42	3.E-05	76	4.E-05	77	4.E-05	78	5.E-05	48	5.E-05
NI--63	129	3.E-05	130	3.E-05	131	3.E-05	112	5.E-05	113	5.E-05	132	6.E-05	114	1.E-04	61	3.E-04
QA-223	124	3.E-05	125	3.E-05	126	4.E-05	56	5.E-05	57	5.E-05	58	6.E-05	127	3.E-04	59	5.E-04
MO--99	46	3.E-05	47	4.E-05	42	5.E-05	41	6.E-05	48	3.E-05	43	9.E-05	77	1.E-04	76	1.E-04
H--3	61	3.E-05	62	4.E-05	63	6.E-05	29	7.E-05	30	9.E-05	129	1.E-04	131	2.E-04	130	1.E-04
Y--90	46	3.E-05	47	4.E-05	48	9.E-05	41	1.E-04	42	1.E-04	76	1.E-04	77	1.E-04	43	3.E-04
Y--93	41	3.E-05	42	6.E-05	46	8.E-05	47	1.E-04	76	4.E-04	77	7.E-04	125	3.E-03	124	2.E-03
NP-93M	76	3.E-05	77	3.E-05	78	3.E-05	79	4.E-05	86	4.E-05	52	5.E-05	46	1.E-04	47	1.E-04
ND-147	46	4.E-05	47	4.E-05	76	4.E-05	77	4.E-05	48	5.E-05	78	5.E-05	41	6.E-05	42	6.E-05
CU--64	41	4.E-05	42	6.E-05	46	2.E-04	47	2.E-04	76	8.E-04	77	1.E-03	43	4.E-03	48	2.E-02
P--32	76	5.E-05	77	5.E-05	46	5.E-05	47	5.E-05	78	5.E-05	48	6.E-05	41	2.E-04	42	2.E-04
CF-141	76	5.E-05	77	5.E-05	78	5.E-05	46	9.E-05	47	9.E-05	48	1.E-04	79	1.E-04	41	2.E-04
TE125M	129	5.E-05	130	4.E-04	61	5.E-04	76	7.E-04	77	7.E-04	78	9.E-04	79	1.E-03	46	2.E-03
U--235	129	5.E-05	130	5.E-05	131	5.E-05	132	5.E-05	133	5.E-05	112	1.E-04	113	1.E-04	114	1.E-04
PU-239	124	5.E-05	125	5.E-05	106	5.E-05	107	5.E-05	104	1.E-04	109	1.E-04	125	1.E-04	124	1.E-04
PP-144	41	5.E-05	46	3.E-03	76	2.E-02	124	5.E+03	56	3.E+04	42	7.E+04	139	3.E+06	96	1.E+06
TE-129	41	6.E-05	46	2.E-03	76	9.E-03	42	2.E-02	47	4.E-01	124	1.E+04	77	2.E+00	56	7.E+00
LA-141	41	7.E-05	46	3.E-04	42	4.E-04	47	1.E-03	76	1.E-03	77	4.E-03	124	1.E-02	78	1.E-02
TH-227	127	8.E-05	126	1.E-04	59	1.E-04	125	2.E-04	58	3.E-04	124	3.E-04	129	1.E-02	57	2.E-03
QC--P5	41	4.E-05	46	2.E-02	42	2.E-02	76	8.E-02	47	2.E-01	77	1.E+00	56	2.E+01	52	4.E+01
TC-99M	41	9.E-05	42	2.E-04	46	8.E-04	47	2.E-03	76	4.E-03	77	1.E-02	125	1.E+00	124	4.E+01
RH-105	41	9.E-05	42	1.E-04	46	1.E-04	47	1.E-04	43	5.E-04	76	5.E-04	77	6.E-04	48	6.E-04
GC--51	76	1.E-04	77	1.E-04	78	1.E-04	46	2.E-04	47	2.E-04	48	2.E-04	41	2.E-04	42	2.E-04
GS-135	52	2.E-04	53	2.E-04	54	2.E-04	55	2.E-04	61	3.E-04	62	3.E-04	64	3.E-04	63	3.E-04
PM-147	76	3.E-04	77	3.E-04	78	3.E-04	79	3.E-04	86	3.E-04	52	6.E-04	46	1.E-03	47	1.E-03
NI--59	129	4.E-04	130	4.E-04	131	4.E-04	132	4.E-04	133	4.E-04	112	6.E-04	113	6.E-04	114	6.E-04
RD--83	41	4.E-04	46	2.E-03	42	6.E-03	76	1.E-02	47	3.E-02	77	1.E-01	124	3.E+00	56	1.E+00
ZN--64	41	7.E-04	46	6.E-03	76	3.E-02	42	5.E-01	47	5.E+00	124	8.E+00	77	2.E+01	56	4.E+01
TE-127	46	9.E-04	41	1.E-03	47	2.E-03	42	2.E-03	76	5.E-03	124	8.E-03	125	2.E-02	77	9.E-03
NE--55	129	5.E-03	124	5.E-03	125	5.E-03	126	5.E-03	127	5.E-03	130	5.E-03	128	6.E-03	61	7.E-03
FO-239	124	6.E-03	125	7.E-03	126	2.E-02	127	2.E+02	104	2.E+02	105	2.E+02	106	2.E+02	107	2.E+02
NI--65	124	9.E-02	125	9.E-01	56	2.E+00	57	2.E+01	134	3.E+03	135	4.E+04	66	6.E+04	96	1.E+05

TABLE 4-4 (contd)

CONCENTRATION LIMITS (UCI/GM)

TABLE 25	- CASE I-E	-- SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE 26	- CASE I-E	-- SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE 27	- CASE I-E	-- SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE 29	- CASE I-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE 30	- CASE I-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE 41	- CASE I-I	-- SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE 42	- CASE I-I	-- SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
TABLE 43	- CASE I-I	-- SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER 0.01 YEARS
TABLE 46	- CASE I-J	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 6 DECAY
TABLE 47	- CASE I-J	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.001 YR
TABLE 48	- CASE I-J	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR
TABLE 49	- CASE I-J	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.1 YRS
TABLE 51	- CASE I-J	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 10 YRS
TABLE 52	- CASE I-K	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE 53	- CASE I-K	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 10 YR
TABLE 54	- CASE I-K	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 Y
TABLE 55	- CASE I-K	-- SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 1E3 Y
TABLE 56	- CASE II-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER NO DECAY
TABLE 57	- CASE II-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.001 YEARS DECAY
TABLE 58	- CASE II-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.01 YEARS DECAY
TABLE 59	- CASE II-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 60	- CASE II-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE 1 YEAR DECAY
TABLE 61	- CASE II-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
TABLE 62	- CASE II-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 1 YEAR DECAY
TABLE 63	- CASE II-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 10 YEARS DECAY
TABLE 64	- CASE II-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 100 YEARS DECAY
TABLE 66	- CASE II-G	-- FILL WANTED DISPOSAL	- EROSION INTO WATERCOURSE AFTER NO DECAY
TABLE 76	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY
TABLE 77	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 0.001 YRS
TABLE 78	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 0.01 YEARS
TABLE 79	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 0.1 YEARS
TABLE 80	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 1 YEAR
TABLE 81	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 10 YEARS
TABLE 82	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 100 YEARS
TABLE 83	- CASE II-K	-- FILL WANTED - GROUND	SURFACE EXPOSURE TO RESIDENTS AFTER 1000 YEARS
TABLE 96	- CASE III-C	-- SANITARY LANDFILL	- INHALATION SPILLED WASTE AFTER NO DECAY
TABLE 104	- CASE III-D	-- SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE 105	- CASE III-D	-- SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 10 YRS
TABLE 106	- CASE III-D	-- SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 100 YR
TABLE 107	- CASE III-D	-- SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 1000 Y
TABLE 108	- CASE III-E	-- SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE 109	- CASE III-E	-- SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE 112	- CASE III-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE 113	- CASE III-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE 114	- CASE III-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE 115	- CASE III-F	-- SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 1000 YEARS
TABLE 124	- CASE IV-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER NO DECAY
TABLE 125	- CASE IV-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.001 YEARS DECAY
TABLE 126	- CASE IV-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.01 YEARS DECAY
TABLE 127	- CASE IV-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 128	- CASE IV-E	-- FILL WANTED DISPOSAL	- CHILD EATS WASTE AFTER 1 YEAR DECAY
TABLE 129	- CASE IV-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
TABLE 130	- CASE IV-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 1 YEAR DECAY
TABLE 131	- CASE IV-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 10 YEARS DECAY
TABLE 132	- CASE IV-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 100 YEARS DECAY
TABLE 133	- CASE IV-F	-- FILL WANTED DISPOSAL	- FOOD GROWN IN WASTE AFTER 1000 YEARS DECAY
TABLE 134	- CASE IV-G	-- FILL WANTED DISPOSAL	- EROSION INTO WATERCOURSE AFTER NO DECAY
TABLE 135	- CASE IV-G	-- FILL WANTED DISPOSAL	- EROSION INTO WATERCOURSE AFTER 0.001 YEARS
TABLE 139	- CASE IV-H	-- FILL WANTED DISPOSAL	- INHALATION OF WASTE ERODED AFTER NO DECAY

TABLE 4-5

**MOST RESTRICTIVE ACTIVITY CONCENTRATION LIMITS FOR
SOLID WASTE DISPOSAL IN A SANITARY LANDFILL
CONCENTRATION LIMITS (UCI/GM)**

NUCLIDE	DE MINIMUS LIMIT		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN														
H---3	29	7.E-15	38	9.E-05	112	2.E-06	113	3.E-04	31	1.E-02	114	4.E-02	25	3.E-01	26	4.E-01
C---14	112	5.E-16	113	5.E-06	114	6.E-06	115	6.E-06	29	9.E-06	30	9.E-06	31	9.E-06	32	1.E-05
NA---24	41	3.E-16	42	4.E-06	46	8.E-06	47	1.E-15	43	2.E-04	48	5.E-04	5	3.E-04	13	3.E-04
P---32	46	5.E-05	47	5.E-05	48	6.E-05	41	2.E-04	42	2.E-04	43	2.E-04	49	3.E-04	44	1.E-03
CR---51	46	2.E-04	47	2.E-04	48	2.E-04	41	2.E-04	42	2.E-04	43	2.E-04	49	5.E-04	44	5.E-04
MN---54	46	9.E-06	47	9.E-06	48	9.E-06	49	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05	44	1.E-05
MN---56	41	6.E-16	42	6.E-15	46	1.E-04	47	1.E-03	89	2.E-02	89	4.E-03	96	6.E-04	5	2.E-04
FE---55	109	2.E-02	25	3.E-02	112	3.E-02	29	5.E-02	109	8.E-02	26	1.E-01	113	1.E-01	31	2.E-01
FE---59	46	6.E-16	47	7.E-06	48	7.E-06	41	9.E-06	42	9.E-06	43	1.E-05	49	1.E-05	44	2.E-05
CO---58	46	7.E-06	47	7.E-06	48	7.E-06	41	9.E-06	42	9.E-06	43	1.E-05	49	1.E-05	44	2.E-05
CO---61	52	9.E-7	53	2.E-06	46	3.E-06	47	3.E-06	49	3.E-06	43	1.E-05	49	1.E-05	44	2.E-05
NI---59	112	6.E-16	113	6.E-04	114	6.E-04	115	6.E-04	29	1.E-03	30	1.E-03	31	1.E-03	32	1.E-03
NI---63	112	5.E-15	113	5.E-05	114	1.E-14	29	5.E-04	30	5.E-04	31	1.E-03	108	1.E-03	109	1.E-03
NI---65	96	1.E-05	89	1.E-05	97	1.E-06	89	1.E-06	5	2.E-06	1	1.E-07	2	1.E-07	3	1.E-07
CU---64	41	4.E-05	42	6.E-05	46	2.E-04	47	2.E-04	43	4.E-03	48	2.E-02	96	3.E-04	89	4.E-04
ZN---65	46	1.E-05	47	1.E-05	48	1.E-05	49	1.E-05	41	2.E-05	42	2.E-05	43	2.E-05	44	2.E-05
ZN---69	41	7.E-14	46	6.E-13	42	5.E-11	47	5.E-00	89	3.E-05	96	1.E-06	5	2.E-06	1	1.E-07
PO---73	41	4.E-14	46	2.E-03	42	6.E-13	47	3.E-02	5	5.E-05	88	4.E-06	96	5.E-06	13	2.E-06
PO---84	41	5.E-06	46	4.E-04	42	4.E-01	47	3.E-01	5	4.E-05	88	1.E-06	96	4.E-06	13	1.E-06
PO---85	41	3.E-05	46	2.E-02	42	2.E-02	47	2.E-01	52	4.E-01	53	6.E-01	48	2.E-02	49	2.E-02
PO---86	46	3.E-15	47	3.E-05	48	3.E-05	41	7.E-05	42	7.E-05	43	8.E-05	49	1.E-04	44	3.E-04
PO---89	41	1.E-5	46	1.E-03	42	7.E-03	5	1.E-05	88	2.E-05	47	7.E-05	96	3.E-06	13	2.E-06
PO---89	41	5.E-06	46	9.E-04	47	2.E-01	48	2.E-01	49	3.E-01	42	1.E-00	43	1.E-00	44	2.E-00
SP---89	46	4.E-05	47	4.E-05	48	4.E-05	49	7.E-05	41	2.E-04	42	2.E-04	43	2.E-04	44	4.E-04
SC---91	112	2.E-06	113	2.E-06	29	2.E-06	30	3.E-06	52	3.E-06	53	4.E-06	178	1.E-05	109	1.E-05
SR---91	41	1.E-15	42	1.E-15	46	4.E-05	47	7.E-05	43	4.E-03	48	5.E-03	49	1.E-02	44	7.E-02
SC---92	41	9.E-06	42	4.E-05	46	8.E-15	47	4.E-04	43	2.E-02	48	2.E-03	49	2.E-04	88	9.E-03
Y---90	46	3.E-15	47	4.E-05	48	9.E-15	41	1.E-14	42	1.E-14	43	3.E-04	49	4.E-01	44	1.E-00
Y---91M	41	1.E-05	46	8.E-04	42	2.E-02	47	8.E-02	48	9.E-02	49	1.E-01	43	5.E-01	44	8.E-01
Y---91	46	5.E-05	47	5.E-05	48	5.E-05	49	8.E-05	41	3.E-04	42	3.E-04	43	3.E-04	44	5.E-04
Y---92	41	2.E-05	42	1.E-04	46	2.E-04	47	1.E-03	43	7.E-02	48	5.E-03	96	2.E-04	89	4.E-04
Y---93	41	3.E-15	42	6.E-05	46	8.E-05	47	1.E-04	43	1.E-02	48	3.E-02	89	2.E-03	88	1.E-03
ZR---93	54	2.E-05	55	2.E-05	53	2.E-15	52	3.E-15	51	2.E-04	56	8.E-04	115	3.E-03	114	3.E-03
ZR---95	49	9.E-06	48	8.E-06	47	9.E-06	46	9.E-06	44	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05
ZR---97	42	4.E-06	46	1.E-05	47	2.E-05	41	5.E-05	43	2.E-04	48	5.E-04	97	3.E-03	96	2.E-03
NR---97M	52	5.E-05	46	1.E-04	47	1.E-04	48	1.E-04	53	1.E-04	49	1.E-04	50	2.E-04	51	9.E-04
NR---95	46	9.E-06	47	9.E-06	48	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05	49	2.E-05	44	2.E-05
NR---97	41	1.E-05	46	4.E-04	42	2.E-03	47	7.E-02	88	2.E-04	96	5.E-05	49	3.E-06	1	1.E-07
MO---99	46	3.E-05	47	4.E-05	42	5.E-05	41	6.E-05	48	8.E-05	43	9.E-05	49	3.E-01	44	3.E-01
TC---99M	41	9.E-15	42	2.E-04	46	8.E-04	47	2.E-03	43	2.E-00	48	2.E-01	113	8.E-03	112	8.E-03
TC---99	112	3.E-15	113	3.E-15	114	3.E-15	115	3.E-05	52	8.E-05	53	8.E-05	54	9.E-05	55	8.E-05
OU---103	46	1.E-05	47	1.E-05	48	1.E-05	41	2.E-05	42	2.E-05	43	2.E-05	49	2.E-05	44	3.E-05
RU---105	41	1.E-05	42	4.E-05	46	1.E-04	47	3.E-04	43	3.E-03	48	5.E-03	49	2.E-04	44	1.E-04
RU---106	46	9.E-06	47	9.E-06	48	9.E-06	49	1.E-05	50	2.E-05	42	2.E-05	43	2.E-05	44	2.E-05
RH---105	41	9.E-05	42	1.E-04	46	1.E-14	47	1.E-04	43	5.E-04	48	6.E-04	49	3.E-03	44	2.E-03

TABLE 4-5 (contd)

CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS LIMIT		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN														
AG-110M	46	3.E-06	47	3.E-06	48	3.E-06	49	3.E-06	41	4.E-06	42	4.E-06	43	4.E-06	44	4.E-06
TE-125M	46	2.E-03	47	2.E-03	48	2.E-03	49	3.E-03	41	2.E-02	42	2.E-02	43	2.E-02	44	4.E-02
TE-127M	47	1.E-04	48	1.E-04	46	1.E-04	49	2.E-04	43	1.E-03	44	1.E-03	50	1.E-03	42	2.E-03
TE-127	46	9.E-04	41	1.E-03	47	2.E-03	42	2.E-03	48	6.E-04	43	7.E-04	89	3.E-03	88	2.E-03
TE-129M	46	2.E-05	47	2.E-05	48	3.E-05	42	5.E-05	49	5.E-05	43	5.E-05	44	1.E-04	41	2.E-04
TE-129	41	6.E-05	46	2.E-03	42	2.E-02	47	4.E-01	112	1.E-05	113	1.E-05	115	1.E-05	114	1.E-05
TE-131M	41	8.E-06	42	9.E-06	46	1.E-05	47	2.E-05	43	5.E-05	48	7.E-05	49	2.E-03	44	3.E-03
TE-131	41	2.E-05	46	2.E-03	47	9.E-03	42	1.E-02	48	1.E-02	43	1.E-02	49	2.E-01	44	2.E-01
TE-132	46	4.E-06	47	4.E-06	42	4.E-06	43	7.E-06	48	8.E-06	41	4.E-05	49	9.E-03	44	8.E-03
I--129	112	9.E-07	113	9.E-07	114	9.E-07	115	9.E-07	114	5.E-06	119	5.E-06	116	5.E-06	111	5.E-06
I--131	41	4.E-06	42	6.E-06	46	2.E-05	47	3.E-05	43	5.E-04	48	2.E-03	97	1.E-03	96	7.E-02
I--131	46	2.E-05	47	2.E-05	41	2.E-05	42	2.E-05	48	3.E-05	43	3.E-05	49	4.E-04	44	5.E-04
I--132	41	4.E-06	42	5.E-06	46	8.E-05	47	1.E-03	96	3.E-03	98	1.E-04	97	4.E-04	89	2.E-05
I--133	41	2.E-05	42	2.E-05	46	3.E-05	47	5.E-05	43	3.E-04	48	5.E-04	49	2.E-01	44	5.E-01
I--134	41	5.E-06	46	3.E-04	42	5.E-03	47	3.E-01	96	5.E-03	98	2.E-04	13	7.E-05	5	3.E-06
I--135	41	6.E-06	42	1.E-05	46	3.E-05	47	7.E-05	43	9.E-03	48	4.E-02	97	3.E-03	96	1.E-03
CS-134	52	3.E-06	46	4.E-06	47	4.E-06	48	4.E-06	49	4.E-06	41	5.E-06	42	5.E-06	50	5.E-06
CS-135	52	7.E-06	53	2.E-04	54	2.E-04	55	2.E-04	29	4.E-04	30	4.E-04	31	4.E-04	32	4.E-04
CS-136	46	4.E-06	47	4.E-06	48	5.E-06	41	5.E-06	42	5.E-06	43	6.E-06	49	3.E-05	44	3.E-05
CS-137	52	2.E-06	53	2.E-06	46	9.E-06	47	9.E-06	48	3.E-06	49	9.E-06	51	9.E-06	51	1.E-05
CS-138	41	5.E-06	46	4.E-04	42	4.E-04	47	3.E-04	5	9.E-04	48	1.E-05	96	2.E-06	13	1.E-06
GA-140	49	4.E-06	47	5.E-06	46	5.E-06	43	6.E-06	42	2.E-05	49	2.E-05	44	3.E-05	41	3.E-05
GA-141	41	2.E-05	46	1.E-03	42	4.E-03	47	2.E-02	48	3.E-04	43	4.E-04	49	5.E-04	44	9.E-04
GA-142	41	2.E-05	46	9.E-04	42	3.E-03	47	7.E-02	96	1.E-06	1	1.E-07	2	1.E-07	3	1.E-07
LA-141	41	5.E-06	42	6.E-06	46	7.E-06	47	8.E-06	43	2.E-05	48	3.E-05	49	2.E-04	44	2.E-04
LA-141	41	7.E-05	46	3.E-04	42	4.E-04	47	1.E-03	48	2.E-02	43	3.E-02	49	4.E-02	44	7.E-02
LA-142	41	5.E-06	46	2.E-04	42	4.E-04	47	1.E-02	96	2.E-05	48	2.E-05	1	1.E-07	2	1.E-07
CE-141	46	9.E-05	47	9.E-05	48	1.E-04	41	2.E-04	42	2.E-04	43	2.E-04	49	2.E-04	44	3.E-04
CE-143	46	3.E-05	41	3.E-05	47	3.E-05	42	3.E-05	48	5.E-05	43	9.E-05	49	3.E-04	44	7.E-04
CE-144	46	1.E-05	47	1.E-05	48	1.E-05	49	1.E-05	50	3.E-05	42	5.E-05	43	5.E-05	44	5.E-05
PF-143	46	5.E-06	47	5.E-06	48	8.E-06	41	1.E-05	42	1.E-05	43	2.E-05	49	3.E-05	44	8.E-05
PF-144	41	5.E-05	46	3.E-03	42	7.E-04	96	1.E-06	47	5.E-06	1	1.E-07	2	1.E-07	3	1.E-07
NR-147	46	4.E-05	47	4.E-05	48	5.E-05	41	6.E-05	42	6.E-05	43	7.E-05	49	4.E-04	44	6.E-04
PM-147	52	6.E-04	46	1.E-03	47	1.E-03	48	1.E-03	49	1.E-03	50	1.E-03	53	2.E-03	51	1.E-02
W--147	41	2.E-05	46	2.E-05	46	4.E-05	47	5.E-05	43	2.E-04	48	5.E-04	89	1.E-03	88	8.E-02
RA-223	96	6.E-04	97	6.E-04	98	7.E-04	88	4.E-04	89	5.E-04	99	5.E-04	90	6.E-04	5	7.E-04
RA-226	25	2.E-07	26	2.E-07	27	2.E-07	28	4.E-07	108	5.E-07	119	5.E-07	29	5.E-07	30	5.E-07
AC-227	112	2.E-05	114	2.E-05	113	3.E-05	119	3.E-05	25	5.E-05	26	6.E-05	104	8.E-05	29	8.E-05
TH-227	96	4.E-00	97	4.E-00	98	4.E-00	99	8.E-00	91	1.E-02	96	1.E-02	8	2.E-02	89	3.E-02
PA-231	114	4.E-06	115	8.E-06	113	1.E-05	114	1.E-05	111	1.E-05	112	1.E-05	106	2.E-05	107	2.E-05
U--235	112	1.E-04	113	1.E-04	114	1.E-04	115	1.E-04	108	2.E-04	119	2.E-04	110	2.E-04	111	2.E-04
NP-239	104	2.E-02	105	2.E-02	106	2.E-02	107	2.E-02	109	4.E-02	119	4.E-02	111	4.E-02	110	4.E-02
PU-239	104	5.E-05	105	5.E-05	106	5.E-05	107	5.E-05	108	1.E-04	109	1.E-04	111	1.E-04	110	1.E-04

TABLE 4-5 (contd)

CONCENTRATION LIMITS (UCI/GM)

TABLE	1	- CASE I-A --	SANITARY LANDFILL	- LEACH INTO WATERCOURSE - TRANSIT TIME = 1 YEAR
TABLE	2	- CASE I-A --	SANITARY LANDFILL	- LEACH INTO WATERCOURSE - TRANSIT TIME = 10 YRS
TABLE	3	- CASE I-A --	SANITARY LANDFILL	- LEACH INTO WATERCOURSE - TRANSIT TIME = 100 YRS
TABLE	5	- CASE I-B --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - NO DECAY
TABLE	8	- CASE I-F --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - 0.1 YEARS DECAY
TABLE	13	- CASE I-C --	SANITARY LANDFILL	- INHALATION OF SPILLED WASTE AFTER NO DECAY
TABLE	25	- CASE I-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE	26	- CASE I-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE	27	- CASE I-F --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE	28	- CASE I-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 1000 YEARS
TABLE	29	- CASE I-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE	30	- CASE I-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE	31	- CASE I-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE	32	- CASE I-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 1000 YEARS
TABLE	41	- CASE I-I --	SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE	42	- CASE I-I --	SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
TABLE	43	- CASE I-I --	SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER 0.01 YEARS
TABLE	44	- CASE I-I --	SANITARY LANDFILL	- EXPOSURE TO 55 GALLON DRUMS AFTER 0.1 YEARS
TABLE	45	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY
TABLE	46	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.001 YR
TABLE	47	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR
TABLE	48	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.1 YRS
TABLE	49	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 1 YEAR
TABLE	50	- CASE I-J --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO WORKERS AFTER 10 YRS
TABLE	51	- CASE I-K --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE	52	- CASE I-K --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 10 YR
TABLE	53	- CASE I-K --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 Y
TABLE	54	- CASE I-K --	SANITARY LANDFILL	- GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 1000 Y
TABLE	55	- CASE I-K --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - NO DECAY
TABLE	56	- CASE III-B --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - 0.001 YEARS DECAY
TABLE	57	- CASE III-B --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - 0.01 YEARS DECAY
TABLE	58	- CASE III-B --	SANITARY LANDFILL	- SPILLAGE INTO WATERCOURSE - 0.1 YEARS DECAY
TABLE	59	- CASE III-C --	SANITARY LANDFILL	- INHALATION SPILLED WASTE AFTER NO DECAY
TABLE	60	- CASE III-C --	SANITARY LANDFILL	- INHALATION SPILLED WASTE AFTER 0.001 YEARS
TABLE	61	- CASE III-C --	SANITARY LANDFILL	- INHALATION SPILLED WASTE AFTER 0.01 YEARS
TABLE	62	- CASE III-C --	SANITARY LANDFILL	- INHALATION SPILLED WASTE AFTER 0.1 YEARS DECAY
TABLE	63	- CASE III-D --	SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE	64	- CASE III-D --	SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 10 YRS
TABLE	65	- CASE III-D --	SANITARY LANDFILL	- INHALATION DURING SITE EXCAVATION AFTER 100 YR
TABLE	66	- CASE III-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE	67	- CASE III-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE	68	- CASE III-E --	SANITARY LANDFILL	- CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE	69	- CASE III-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE	70	- CASE III-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE	71	- CASE III-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE	72	- CASE III-F --	SANITARY LANDFILL	- FOOD GROWN ON WASTE SITE AFTER 1000 YEARS

TABLE 4-6

MOST RESTRICTIVE ACTIVITY CONCENTRATION LIMITS FOR
SOLID WASTE DISPOSAL IN A SANITARY LANDFILL
ARRANGED BY INCREASING "DE MINIMUS" CONCENTRATION LIMIT
CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN														
PA-226	25	2.E-07	26	2.E-07	27	2.E-07	28	4.E-07	108	5.E-07	109	5.E-07	29	5.E-07	31	5.E-07
I--129	112	9.E-07	113	9.E-07	114	9.E-07	115	9.E-07	109	5.E-06	109	5.E-06	110	5.E-06	111	5.E-06
CO--60	52	9.E-07	53	2.E-06	46	3.E-06	47	3.E-06	49	3.E-06	49	3.E-06	50	4.E-06	41	5.E-06
CS-137	52	2.E-06	53	2.E-06	46	9.E-06	47	9.E-06	48	9.E-06	49	9.E-06	50	9.E-06	51	1.E-05
SR--90	112	2.E-06	113	2.E-06	29	2.E-06	31	3.E-06	52	3.E-06	53	4.E-06	108	1.E-05	109	1.E-05
AG110M	46	3.E-06	47	3.E-06	48	3.E-06	49	3.E-06	41	4.E-06	42	4.E-06	43	4.E-06	44	4.E-06
NA--24	41	3.E-06	42	4.E-06	46	4.E-06	47	1.E-05	43	2.E-06	48	5.E-06	5	3.E-06	13	3.E-06
CS-134	52	3.E-06	46	4.E-06	47	4.E-06	48	4.E-06	49	4.E-06	41	5.E-06	42	5.E-06	50	5.E-06
TE-132	46	4.E-06	47	4.E-06	42	4.E-06	43	7.E-06	48	8.E-06	41	4.E-05	49	9.E-06	44	8.E-06
I--132	41	4.E-06	42	5.E-05	46	8.E-05	47	1.E-03	96	3.E+03	98	1.E+04	97	4.E+04	89	2.E+05
CS-136	46	4.E-06	47	4.E-06	48	5.E-06	41	5.E-06	42	5.E-06	43	6.E-06	49	3.E-05	44	3.E-05
TA-140	48	4.E-06	47	5.E-06	46	5.E-06	43	6.E-06	42	2.E-05	49	2.E-05	44	3.E-05	41	3.E-05
I--137	41	4.E-06	42	6.E-06	46	2.E-05	47	3.E-05	43	5.E-06	48	2.E-06	97	1.E+03	96	7.E+02
QR--89	41	5.E-06	46	8.E-06	47	2.E-01	48	2.E-01	49	3.E-01	42	1.E+00	43	1.E+00	44	2.E+00
CS-134	41	5.E-06	46	4.E-06	42	4.E-06	47	3.E+01	5	9.E+04	98	1.E+05	96	2.E+06	13	1.E+06
PF-143	46	5.E-06	47	5.E-06	48	6.E-06	41	1.E-05	42	1.E-05	43	2.E-05	49	3.E-05	44	8.E-05
QR--84	41	5.E-06	46	4.E-06	42	4.E-06	47	3.E+01	5	4.E+05	98	1.E+06	96	4.E+06	13	1.E+06
I--134	41	5.E-06	46	3.E-06	42	5.E-06	47	3.E-01	96	5.E+03	98	2.E+04	13	7.E+05	5	3.E+06
LA-140	41	5.E-06	42	6.E-06	46	7.E-06	47	8.E-06	43	2.E-05	48	3.E-05	49	2.E+01	44	2.E+01
LA-142	41	5.E-06	46	2.E-06	42	4.E-06	47	1.E-02	96	2.E+05	98	2.E+05	1	1.E+07	2	1.E+07
C--14	112	5.E-06	113	5.E-06	114	6.E-06	115	6.E-06	29	3.E-06	30	9.E-06	31	9.E-06	32	1.E-05
AN--56	41	6.E-06	42	6.E-05	46	1.E-04	47	1.E-03	88	4.E+02	99	4.E+03	96	6.E+04	5	2.E+04
I--135	41	6.E-06	42	1.E-05	46	3.E-05	47	7.E-05	43	8.E-03	48	4.E-02	97	3.E+03	96	1.E+03
FE--59	46	6.E-06	47	7.E-06	48	7.E-06	41	9.E-06	42	9.E-06	43	1.E-05	49	1.E-05	44	2.E-05
CO--59	46	7.E-06	47	7.E-06	48	7.E-06	41	9.E-06	42	9.E-06	43	1.E-05	49	1.E-05	44	1.E-05
79--07	42	8.E-06	46	1.E-05	47	2.E-05	41	5.E-05	43	2.E-04	48	5.E-04	97	3.E+03	96	2.E+03
SO--02	41	8.E-06	42	4.E-05	46	8.E-05	47	4.E-04	43	2.E+02	48	2.E+03	89	2.E+04	88	9.E+03
7R--95	49	8.E-06	48	8.E-06	47	9.E-06	46	9.E-06	44	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05
TE131M	41	9.E-06	42	9.E-06	46	1.E-05	47	2.E-05	43	5.E-05	48	7.E-05	49	2.E-03	44	3.E-03
PA-231	114	9.E-06	115	8.E-06	113	1.E-05	111	1.E-05	111	1.E-05	112	1.E-05	106	2.E-05	107	2.E-05
AN--54	46	9.E-06	47	9.E-06	48	9.E-06	49	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05	44	1.E-05
RU-106	46	9.E-06	47	9.E-06	48	9.E-06	49	1.E-05	50	2.E-05	42	2.E-05	43	2.E-05	44	2.E-05
AN--05	46	9.E-06	47	9.E-06	48	1.E-05	41	1.E-05	42	1.E-05	43	1.E-05	49	2.E-05	44	2.E-05
QB--88	41	1.E-05	46	1.E-05	42	7.E+03	5	1.E+05	88	2.E+05	47	7.E+05	96	3.E+06	13	2.E+06
71--65	45	1.E-05	47	1.E-05	48	1.E-05	49	1.E-05	41	2.E-05	42	2.E-05	43	2.E-05	44	2.E-05
NB--97	41	1.E-05	46	4.E-04	42	2.E-03	47	7.E-02	88	2.E+04	96	5.E+05	89	3.E+06	1	1.E+07
PU-103	46	1.E-05	47	1.E-05	48	1.E-05	41	2.E-05	42	2.E-05	43	2.E-05	49	2.E-05	44	3.E-05
QU-115	41	1.E-05	42	4.E-05	46	1.E-04	47	3.E-04	43	3.E-03	48	5.E-03	49	2.E+04	44	1.E+04
SK--91	41	1.E-05	42	1.E-05	46	4.E-05	47	7.E-05	43	4.E-03	48	5.E-03	49	1.E-02	44	7.E-02
Y--91M	41	1.E-05	46	8.E-04	42	2.E-02	47	8.E-02	49	9.E-02	49	1.E-01	43	5.E-01	44	8.E-01
CE-144	46	1.E-05	47	1.E-05	48	1.E-05	49	1.E-05	50	3.E-05	42	5.E-05	43	5.E-05	44	5.E-05
I--133	41	2.E-05	42	2.E-05	46	3.E-05	47	5.E-05	43	3.E-04	48	5.E-04	49	2.E-01	44	5.E-01
RA-142	41	2.E-05	46	9.E-04	42	3.E-03	47	7.E-02	96	1.E+06	1	1.E+07	2	1.E+07	3	1.E+07
I--131	46	2.E-05	47	2.E-05	41	2.E-05	42	2.E-05	48	3.E-05	43	3.E-05	49	4.E-04	44	5.E-04
RA-141	41	2.E-05	46	1.E-03	42	4.E-03	47	2.E-02	48	3.E-01	43	4.E-01	49	5.E-01	44	9.E-01

TABLE 4-6 (contd)

CONCENTRATION LIMITS (UCI/GM)

NUCLIDE	DE MINIMUS		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING		LIMITING	
	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN	TABLE	CONCEN
M--187	41	2.E-05	42	2.E-05	46	4.E-05	47	5.E-05	43	2.E-04	48	5.E-04	89	1.E+03	88	8.E+02
TR--03	54	2.E-05	55	2.E-05	53	2.E-05	52	3.E-05	51	2.E-04	50	8.E-04	115	3.E-03	114	3.E-03
AC-227	112	2.E-05	168	2.E-05	113	3.E-05	109	3.E-05	25	5.E-05	26	6.E-05	104	8.E-05	29	8.E-05
TE-131	41	2.E-05	46	2.E-03	47	9.E-03	42	1.E-02	48	1.E-02	43	1.E-02	49	2.E-01	44	2.E-01
Y--92	41	2.E-05	42	1.E-04	46	2.E-04	47	1.E-03	43	7.E+02	48	5.E+03	96	2.E+04	89	4.E+04
TE120M	46	2.E-05	47	2.E-05	48	3.E-05	42	5.E-05	49	5.E-05	43	5.E-05	44	1.E-04	41	2.E-04
RG--A6	46	3.E-05	47	3.E-05	48	3.E-05	41	7.E-05	42	7.E-05	43	8.E-05	49	1.E-04	44	3.E-04
TC--09	112	3.E-05	113	3.E-05	114	3.E-05	115	3.E-05	52	8.E-05	53	8.E-05	54	8.E-05	55	8.E-05
CE-143	46	3.E-05	41	3.E-05	47	3.E-05	42	3.E-05	48	5.E-05	43	9.E-05	49	3.E-04	44	7.E-04
MO--09	46	3.E-05	47	4.E-05	42	5.E-05	41	6.E-05	48	8.E-05	43	9.E-05	49	3.E-04	44	7.E-04
Y--90	46	3.E-05	47	4.E-05	48	9.E-05	41	1.E-04	42	1.E-04	43	3.E-04	49	3.E-04	44	7.E-04
Y--93	41	3.E-05	42	6.E-05	46	8.E-05	47	1.E-04	42	1.E-04	43	3.E-04	49	3.E-04	44	7.E-04
NP-147	46	4.E-05	47	4.E-05	48	5.E-05	41	6.E-05	42	1.E-04	43	3.E-04	49	3.E-04	44	7.E-04
CU--F4	41	4.E-05	42	6.E-05	46	2.E-04	47	2.E-04	43	6.E-05	48	7.E-05	49	4.E-04	44	6.E-04
SQ--A9	46	4.E-05	47	4.E-05	48	4.E-05	49	7.E-05	41	2.E-04	42	2.E-04	43	2.E-04	44	4.E-04
P--32	46	5.E-05	47	5.E-05	48	6.E-05	41	2.E-04	42	2.E-04	43	2.E-04	49	3.E-04	44	4.E-04
NI--63	112	5.E-05	113	5.E-05	114	1.E-04	29	5.E-04	30	5.E-04	31	1.E-03	108	1.E-03	109	1.E-03
OU-239	134	5.E-05	165	5.E-05	106	5.E-05	107	5.E-05	108	1.E-04	109	1.E-04	110	1.E-04	111	1.E-04
Y--91	46	5.E-05	47	5.E-05	48	5.E-05	49	8.E-05	41	3.E-04	42	3.E-04	43	3.E-04	44	5.E-04
PP-144	41	5.E-05	46	3.E-03	42	7.E+04	9E	1.E+06	47	5.E+06	1	1.E+07	2	1.E+07	3	1.E+07
NR-93M	52	5.E-05	46	1.E-04	47	1.E-04	48	1.E-04	53	1.E-04	49	1.E-04	50	2.E-04	51	9.E-04
TE-129	41	6.E-05	46	2.E-03	42	2.E-02	47	4.E-01	112	1.E+05	113	1.E+05	114	1.E+05	115	1.E+05
H--03	29	7.E-05	30	9.E-05	112	2.E-04	113	3.E-04	31	1.E-02	114	4.E-02	25	3.E-01	26	4.E-01
LA-141	41	7.E-05	46	3.E-04	42	4.E-04	47	1.E-03	48	2.E-02	43	3.E-02	49	4.E-02	44	7.E-02
PO--85	41	4.E-05	46	2.E-02	42	2.E-02	47	2.E-03	52	4.E+01	53	6.E+01	48	2.E+02	49	2.E+02
TC-904	41	9.E-05	42	2.E-04	46	4.E-04	47	2.E-03	43	2.E+00	48	2.E+01	113	8.E+03	112	8.E+03
PH-105	41	9.E-05	42	1.E-04	46	1.E-04	47	1.E-04	43	5.E-04	48	6.E-04	49	3.E+03	44	2.E+03
CE-141	46	9.E-05	47	9.E-05	48	1.E-04	41	2.E-04	42	2.E-04	43	2.E-04	49	2.E-04	44	3.E-04
U--235	112	1.E-04	113	1.E-04	114	1.E-04	115	1.E-04	108	2.E-04	109	2.E-04	110	2.E-04	111	2.E-04
TF127M	47	1.E-04	48	1.E-04	49	1.E-04	50	2.E-04	43	1.E-03	44	1.E-03	56	1.E-03	42	2.E-03
CS-135	52	2.E-04	53	2.E-04	54	2.E-04	55	2.E-04	29	4.E-04	30	4.E-04	31	4.E-04	32	4.E-04
GP--51	46	2.E-04	47	2.E-04	48	2.E-04	41	2.E-04	42	2.E-04	43	2.E-04	49	5.E-04	44	5.E-04
QC--A3	41	4.E-04	46	2.E-03	42	6.E-03	47	3.E-02	5	5.E+05	88	1.E+06	96	5.E+06	13	2.E+06
PM-147	52	6.E-04	46	1.E-03	47	1.E-03	48	1.E-03	49	1.E-03	50	1.E-03	53	2.E-03	51	1.E-02
NI--59	112	6.E-04	113	6.E-04	114	6.E-04	115	6.E-04	29	1.E-03	30	1.E-03	31	1.E-03	32	1.E-03
ZN--69	41	7.E-04	46	6.E-03	42	5.E-01	47	5.E+00	88	3.E+05	96	1.E+06	5	2.E+06	1	1.E+07
TE-127	46	9.E-04	41	1.E-03	47	2.E-03	42	2.E-03	48	6.E-01	43	7.E-01	89	3.E+03	88	2.E+03
TE125M	46	2.E-03	47	2.E-03	48	2.E-03	49	3.E-03	41	2.E-02	42	2.E-02	43	2.E-02	44	4.E-02
FE--55	108	2.E-02	25	3.E-02	112	3.E-02	29	5.E-02	109	9.E-02	26	1.E-01	113	1.E-01	31	2.E-01
TH-227	96	4.E+01	97	4.E+01	98	4.E+01	99	8.E+01	91	1.E+02	98	1.E+02	8	2.E+02	89	3.E+02
PA-223	96	6.E+00	97	6.E+00	98	7.E+00	99	4.E+01	89	5.E+01	99	5.E+01	90	6.E+01	5	7.E+01
ND-239	104	2.E+02	105	2.E+02	106	2.E+02	107	2.E+02	108	4.E+02	109	4.E+02	110	4.E+02	111	4.E+02
NI--65	96	1.E+05	88	1.E+05	97	1.E+06	89	1.E+06	5	2.E+06	1	1.E+07	2	1.E+07	3	1.E+07

TABLE 4-6 (contd)

CONCENTRATION LIMITS (UCI/GM)

TABLE	1	-	CASE I-A	--	SANITARY LANDFILL	-	LEACH INTO WATERCOURSE - TRANSIT TIME = 1 YEAR
TABLE	2	-	CASE I-A	--	SANITARY LANDFILL	-	LEACH INTO WATERCOURSE - TRANSIT TIME = 10 YRS
TABLE	3	-	CASE I-A	--	SANITARY LANDFILL	-	LEACH INTO WATERCOURSE - TRANSIT TIME = 100 YRS
TABLE	5	-	CASE I-B	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - NO DECAY
TABLE	8	-	CASE I-B	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - 0.1 YEARS DECAY
TABLE	13	-	CASE I-C	--	SANITARY LANDFILL	-	INHALATION OF SPILLED WASTE AFTER NO DECAY
TABLE	25	-	CASE I-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE	26	-	CASE I-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE	27	-	CASE I-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE	29	-	CASE I-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 1000 YEARS
TABLE	29	-	CASE I-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE	31	-	CASE I-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE	31	-	CASE I-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE	32	-	CASE I-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 1000 YEARS
TABLE	41	-	CASE I-I	--	SANITARY LANDFILL	-	EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE	42	-	CASE I-I	--	SANITARY LANDFILL	-	EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
TABLE	43	-	CASE I-I	--	SANITARY LANDFILL	-	EXPOSURE TO 55 GALLON DRUMS AFTER 0.01 YEARS
TABLE	44	-	CASE I-I	--	SANITARY LANDFILL	-	EXPOSURE TO 55 GALLON DRUMS AFTER 0.1 YEARS
TABLE	46	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 1 DECAY
TABLE	47	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.001 YR
TABLE	48	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR
TABLE	49	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.1 YRS
TABLE	51	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 1 YEAR
TABLE	51	-	CASE I-J	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO WORKERS AFTER 10 YRS
TABLE	52	-	CASE I-K	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE	53	-	CASE I-K	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 10 YR
TABLE	54	-	CASE I-K	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 Y
TABLE	55	-	CASE I-K	--	SANITARY LANDFILL	-	GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 100 Y
TABLE	98	-	CASE III-P	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - NO DECAY
TABLE	99	-	CASE III-P	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - 0.001 YEARS DECAY
TABLE	100	-	CASE III-P	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - 0.01 YEARS DECAY
TABLE	91	-	CASE III-Q	--	SANITARY LANDFILL	-	SPILLAGE INTO WATERCOURSE - 0.1 YEARS DECAY
TABLE	96	-	CASE III-C	--	SANITARY LANDFILL	-	INHALATION SPILLED WASTE AFTER NO DECAY
TABLE	97	-	CASE III-C	--	SANITARY LANDFILL	-	INHALATION SPILLED WASTE AFTER 0.001 YEARS
TABLE	98	-	CASE III-C	--	SANITARY LANDFILL	-	INHALATION SPILLED WASTE AFTER 0.01 YEARS
TABLE	99	-	CASE III-C	--	SANITARY LANDFILL	-	INHALATION SPILLED WASTE AFTER 0.1 YEARS DECAY
TABLE	104	-	CASE III-D	--	SANITARY LANDFILL	-	INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE	105	-	CASE III-D	--	SANITARY LANDFILL	-	INHALATION DURING SITE EXCAVATION AFTER 10 YRS
TABLE	106	-	CASE III-D	--	SANITARY LANDFILL	-	INHALATION DURING SITE EXCAVATION AFTER 100 YR
TABLE	107	-	CASE III-D	--	SANITARY LANDFILL	-	INHALATION DURING SITE EXCAVATION AFTER 1000 Y
TABLE	108	-	CASE III-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS
TABLE	109	-	CASE III-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 10 YEARS
TABLE	110	-	CASE III-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 100 YEARS
TABLE	111	-	CASE III-E	--	SANITARY LANDFILL	-	CHILD EATS DIRT ON WASTE SITE AFTER 1000 YEARS
TABLE	112	-	CASE III-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 5 YEARS
TABLE	113	-	CASE III-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 10 YEARS
TABLE	114	-	CASE III-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 100 YEARS
TABLE	115	-	CASE III-F	--	SANITARY LANDFILL	-	FOOD GROWN ON WASTE SITE AFTER 1000 YEARS

5.0 COST-BENEFIT CONSIDERATIONS

Conceptually, cost-benefit analysis can be applied to disposal of solid wastes with a "de minimus" radioactivity concentration by weighting costs and benefits of alternate means of disposal. In lieu of any other guidance, the interim value of \$1,000 per total body man-rem from Appendix I is used herein. In practice, the limited distribution of discarded bulk solid wastes and the critical pathways for exposure of man limit the number of people potentially exposed to those who live on the disposal site or who eat food grown thereon. Therefore, large population doses will not result from disposal of material with "de minimus" concentrations of radioactivity.

Assuming the cost of unrestricted disposal of "de minimus" solid waste is zero, the cost of shallow-land burial of low-level radioactive waste is \$6/ft³, and the population dose associated with shallow-land burial is zero, then a practical cost-benefit criterion for unrestricted disposal of solid waste is that any waste having an associated population dose potential of less than 6 man-millirem per cubic foot of waste discarded in an unrestricted manner is "de minimus."

As an illustration that the individual dose rate criterion is more limiting than the cost-benefit criterion, consider the example of the disposal of 150 m³ of spent, powdered resin, approximately the volume generated annually at a large light-water reactor power station. If unrestricted disposal causes more than 6 man-mrem/ft³, or about 30 man-rem for disposal of the total volume of the waste, then the alternate, shallow-land burial, would be indicated by ALARA considerations. Since the "de minimus" health protection criterion limits the individual dose

rate to 1 mrem total body dose per year, about 600 persons, each receiving 1 mrem/year for 50 years would be required to reach the limit associated with the cost benefit criterion, 30 man-rem, for disposal of the 150 m³ of waste. Since all of the limiting pathways require that the exposed individual reside directly on the disposal sites or eat food grown thereon, it is hardly reasonable to expect the population exposure to reach the limit of the cost-benefit criterion. Hence, the "de minimus" limit based on individual dose will result in a lower limit than one based on ALARA considerations.

With such a low individual total body dose rate of one millirem per year or less, any cost-benefit interpretation based on an estimate of population integrated dose equivalent is probably unrealistic. The NCRP and ICRP cautions in regard to the inappropriateness of quantitative risk-benefit balancing at such a low dose rate is thus persuasive against the use of such an analysis for decisionmaking in connection with "de minimus" waste disposal (NC75a, IC73).

6.0 APPLICATION OF THE GENERIC METHOD

The aim of this study has been to develop a method for determining "de minimus" concentrations in homogeneous, bulk solid wastes so that they may be disposed of in the manner of ordinary domestic solid wastes without any special requirements because of the low radioactivity content. The methodology developed has been applied to land disposal of spent, powdered resin from PWR secondary systems as an example. Neither initial dispersion by air or water, i.e., incineration or sea dumping, were considered; however, the methodology developed can be applied to other materials by considering the nature of the source, feasible disposal scenarios, and environmental pathways to man.

6.1 Application to Secondary Resins

As an example of the application of the method, the expected concentration of each radionuclide adsorbed on spent, powdered resin from PWR secondary systems has been computed using the PWR GALE code (NRC76) to calculate primary coolant concentrations and the SECONDARY code (by Nuclear Safety Associates) to calculate activity concentrations of the spent resins. The "de minimus" concentrations calculated in Section 4 apply, of course, to this type of waste. By comparing the expected concentrations to the "de minimus" concentration limits, it is possible to rank the isotopes in order of significance. The sum of the ratios of expected to "de minimus" concentrations of all radionuclides in the waste must not exceed unity if the waste itself is to be "de minimus." This method is also summarized in Figure 6-1.

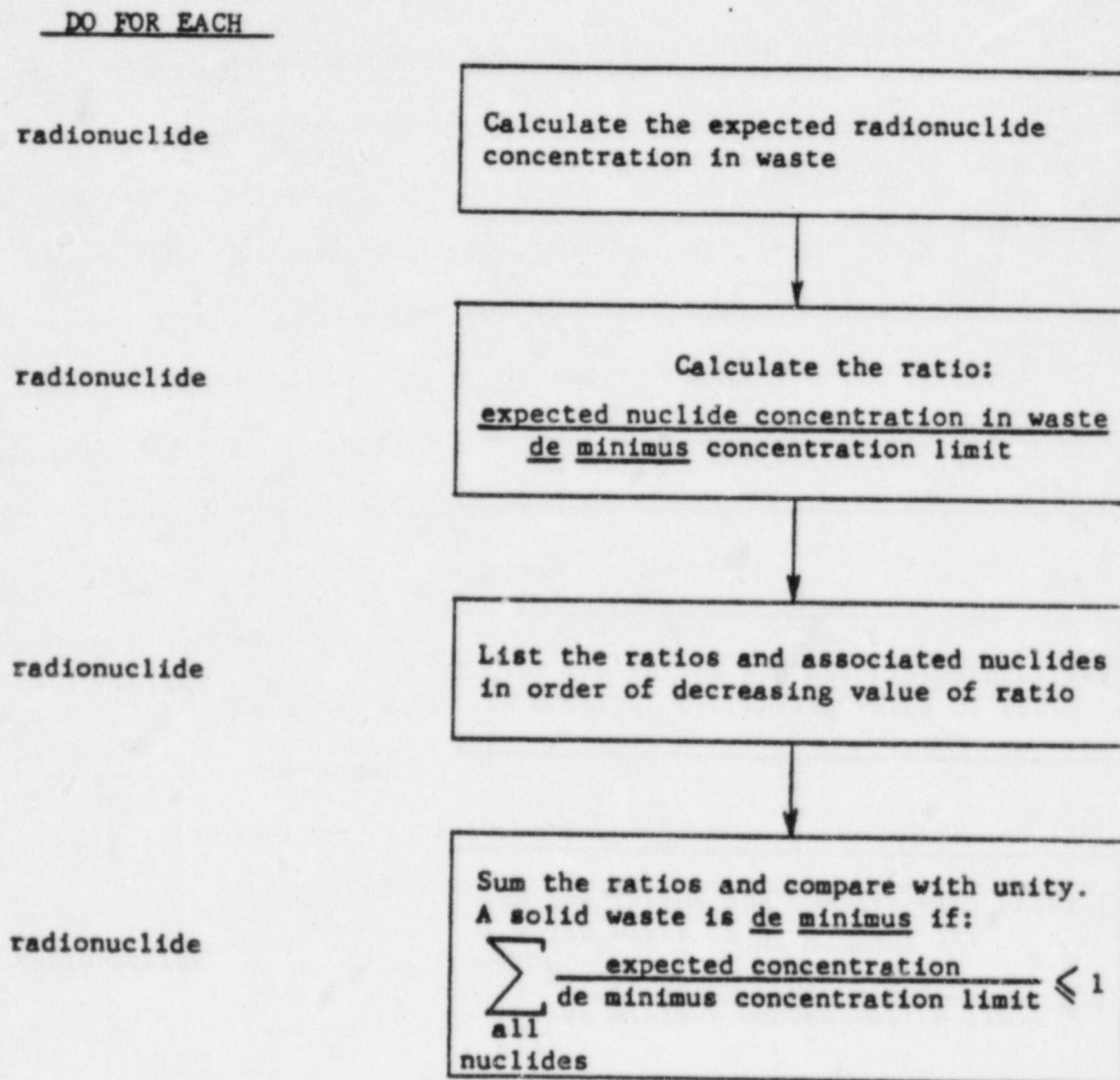


Figure 6-1 Summary Diagram of Method of Calculating Whether Waste Is "de minimus"

The ratios of computed concentrations in spent, powdered resins from a PWR secondary system to "de minimus" concentration limits after 3, 6, and 12 months' decay are shown respectively in Tables 6-1, 6-2, 6-3. It can be seen that after 3 months decay (Table 6-1), only Cs-134, Cs-137, Co-60 and Co-58 exceed the "de minimus" concentration limits; and after 1 year's decay only Cs-134, Cs-137 and Co-60 are expected to be in excess of the "de minimus" values. Furthermore, they are more than one or two orders of magnitude more limiting than any other isotope. If the concentration of other radionuclides can be related to the concentration of a few indicator nuclides, then verification of the activity concentration of the indicator nuclides should be adequate to verify that the waste is "de minimus." Based on the calculated mixture of radionuclides on spent powdered resin, Cs-137 (with 0.662 Mev gamma ray) and Co-60 (with 1.17 and 1.33 Mev gamma rays) can be used as indicators to measure whether this type of waste is "de minimus." With respect to any particular reactor, specific measurements may be needed to ascertain that Co-60 and Cs-137 are critical radionuclides in spent resin.

Although Tables 6-1, 6-2, and 6-3 indicate that the calculated concentrations of cesium and cobalt do not satisfy the "de minimus" criterion for radiation protection, it should be recognized that the calculation of these radionuclides was based on conservative assumptions. In the PWR GALE code (NRC76), it was assumed that the reactor operated with 0.12% failed fuel and that the water leakage rate from the primary to the secondary loop in the reference reactor was 100 pounds/day. In order to achieve the "expected" concentrations, both of these conditions must occur simultaneously. Most of the time one or both of these param-

eters will be very much lower than the assumed values. Consequently, most of the time the secondary resins will have concentrations much below the "expected" values calculated herein and this type of waste can be expected to meet the "de minimus" concentration much of the time.

6.2 Practicability of Measurement

It can be seen from Tables 4-3 and 4-4, particularly the latter, that levels at which nuclides must be measured to demonstrate compliance with "de minimus" concentrations are in the range of 10^{-6} $\mu\text{Ci}/\text{gram}$. In the case of a specific waste type, such as resins, where it can be demonstrated that only a few radionuclides are important, the number of radionuclides which need be analyzed for can be shown to be small. Furthermore, in the case of spent, powdered resins from PWR secondary systems where the critical radionuclides, Co-60 and Cs-137, emit distinct, energetic gamma rays, the analytical requirement is clear. In this example case, the limit of measurement of the critical nuclides by gamma ray spectrometry is in the order of 0.1 to 1 pCi/g. Both of these nuclides can be measured at the activity concentration necessary to demonstrate compliance with the "de minimus" concentration limits calculated in this study.

Table 6-1

Comparison of Computed Activity Concentrations in Spent Resin
with "de minimus" Concentration Limits Appropriate
for Land Disposal of Homogeneous Bulk Solid Waste

Activity on Resin Decayed for 3 Months Before Disposal

IN ORDER OF DECREASING RATIO OF EXPECTED TO LIMITING VALUES

ISOTOPE	TABLE	LIMITING CONCEN. (UCI/GM)	EXPECTED CONCEN. (UCI/GM)	RATIO OF EXP TO LIM CONCEN.
CS-134	76	9.9E-07	2.6E-04	262.5495
CS-137	52	1.5E-06	2.3E-04	156.3462
CO--60	76	8.1E-07	2.4E-05	29.6624
CO--58	76	2.6E-06	2.4E-05	9.1129
MN--54	76	2.4E-06	2.3E-06	.9575
FE--59	76	2.8E-06	5.7E-07	.2052
SR--90	129	7.5E-07	1.3E-07	.1736
TE127M	129	5.3E-06	7.7E-07	.1447
CE-144	76	3.6E-06	2.3E-07	.0645
ZP--95	76	2.1E-06	7.6E-09	.0360
TE129M	76	1.1E-05	3.9E-07	.0351
RU-106	76	2.4E-06	8.0E-08	.0335
MG--95	76	4.4E-06	1.4E-07	.0318
CS-136	46	3.7E-06	6.4E-09	.0182
SR--89	76	1.6E-05	2.6E-07	.0165
I--131	46	1.8E-05	2.1E-07	.0118
TE-129	41	6.3E-05	3.9E-07	.0061
PR-144	41	5.2E-05	2.3E-07	.0045
Y--90	46	3.4E-05	1.3E-07	.0038
FE--55	129	4.5E-03	1.7E-05	.0038
Y--91	76	1.9E-05	7.2E-08	.0038
RU-103	76	5.6E-06	1.9E-08	.0034
CR--51	76	1.7E-04	2.8E-07	.0028
TE-127	46	9.1E-04	7.6E-07	8.3E-04
TC--99	61	6.3E-08	4.3E-11	6.8E-04
TE125M	129	4.7E-05	2.9E-08	6.2E-04
CE-141	76	4.5E-05	1.7E-08	3.8E-04
BA-140	76	3.1E-06	1.1E-09	3.4E-04
LA-140	41	5.0E-06	1.2E-09	2.4E-04
RB--86	76	1.9E-05	2.8E-09	1.5E-04

TABLE 41 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE 42 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
TABLE 46 -- CASE I-J -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY
TABLE 52 -- CASE I-K -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE 61 -- CASE II-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
TABLE 76 -- CASE II-K -- FILL WANTED - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY
TABLE 114 -- CASE III-D -- SANITARY LANDFILL - INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE 124 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER NO DECAY
TABLE 127 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 129 -- CASE IV-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY

Table 6-2

Comparison of Computed Activity Concentrations in Spent Resin
with "de minimus" Concentration Limits Appropriate
for Land Disposal of Homogeneous Bulk Solid Waste

Activity on Resin Decayed for 6 Months Before Disposal

IN ORDER OF DECREASING RATIO OF EXPECTED TO LIMITING VALUES

ISOTOPE	TABLE	LIMITING CONCEN. (UCI/GM)	EXPECTED CONCEN. (UCI/GM)	RATIO OF EXP TO LIM CONCEN.
CS-134	76	9.9E-07	2.4E-04	241.7684
CS-137	52	1.5E-06	2.3E-04	155.4462
CO--60	76	8.1E-07	2.3E-05	28.6981
CO--58	76	2.6E-06	9.7E-06	3.7392
NN--54	76	2.4E-06	1.9E-06	.7818
SP--90	129	7.5E-07	1.3E-07	.1726
TE127M	129	5.3E-06	4.2E-07	.0792
CE-144	76	3.6E-06	1.9E-07	.0517
FE--59	76	2.8E-06	1.4E-07	.0503
RU-106	76	2.4E-06	6.8E-08	.0282
ZR--95	76	2.1E-06	2.9E-08	.0136
NB--95	76	4.4E-06	5.8E-08	.0132
TE129M	76	1.1E-05	6.0E-09	.0055
SR--89	76	1.6E-05	7.5E-08	.0047
Y--90	46	3.4E-05	1.3E-07	.0038
PR-144	41	5.2E-05	1.9E-07	.0036
FE--55	129	4.5E-03	1.6E-05	.0035
Y--91	76	1.9E-05	2.4E-08	.0013
TE-129	41	6.3E-05	6.0E-09	9.6E-04
RU-103	76	5.6E-06	4.0E-09	7.1E-04
TC--99	61	6.3E-08	4.3E-11	6.8E-04
TE-127	46	9.1E-04	4.2E-07	4.6E-04
CR--51	76	1.4E-04	2.9E-08	2.9E-04
TE129M	129	4.7E-05	9.8E-09	2.1E-04
CS-136	46	3.7E-06	5.2E-10	1.4E-04
CE-141	76	4.9E-05	2.4E-09	5.4E-05
PB--86	76	1.9E-05	9.5E-11	5.0E-06
I--131	46	1.4E-05	8.2E-11	4.4E-06
RA-140	76	3.1E-06	7.4E-12	2.4E-06
LA-140	41	5.9E-06	8.6E-12	1.7E-06

TABLE 41 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
 TABLE 42 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
 TABLE 46 -- CASE I-J -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY
 TABLE 52 -- CASE I-K -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
 TABLE 61 -- CASE II-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY
 TABLE 76 -- CASE II-K -- FILL WANTED - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY
 TABLE 104 -- CASE III-D -- SANITARY LANDFILL - INHALATION DURING SITE EXCAVATION AFTER 5 YRS
 TABLE 124 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER NO DECAY
 TABLE 127 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER 0.1 YEARS DECAY
 TABLE 129 -- CASE IV-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY

Table 6-3

Comparison of Computed Activity Concentrations in Spent Resin
with "de minimus" Concentration Limits Appropriate
for Land Disposal of Homogeneous Bulk Solid Waste

Activity on Resin Decayed for One Year Before Disposal

IN ORDER OF DECREASING RATIO OF EXPECTED TO LIMITING VALUES

ISOTOPE	TABLE	LIMITING CONCEN. (UCI/GM)	EXPECTED CONCEN. (UCI/GM)	RATIO OF EXP TO LIM CONCEN.
CS-134	76	9.9E-07	2.0E-04	205.0108
CS-137	52	1.5E-06	2.3E-04	153.6618
CO--60	76	8.1E-07	2.2E-05	26.8626
CO--58	76	2.6E-05	1.6E-06	.6296
MN--54	76	2.4E-06	1.3E-06	.5212
SR--90	129	7.5E-07	1.3E-07	.1705
CE-144	76	3.6E-06	1.2E-07	.0331
TE127M	129	5.3E-06	1.3E-07	.0237
RU-106	76	2.4E-06	4.8E-08	.0199
Y--91	46	3.4E-05	1.3E-07	.0038
FE--55	129	4.5E-03	1.4E-05	.0031
FE--59	76	2.8E-06	8.5E-09	.0030
PR-144	41	5.2E-05	1.2E-07	.0123
NB--95	76	4.4E-06	8.7E-09	.0020
ZR--95	76	2.1E-06	4.1E-09	.0019
TC--99	61	6.3E-08	4.3E-11	6.4E-04
SR--89	76	1.6E-05	6.2E-09	3.9E-04
Y--91	76	1.9E-05	2.9E-09	1.5E-04
TE-127	46	9.1E-04	1.2E-07	1.4E-04
TE129M	76	1.1E-05	1.5E-09	1.3E-04
RU-103	76	5.6E-06	1.7E-13	3.2E-05
TE125M	129	4.7E-05	1.1E-09	2.4E-05
TE-129	41	6.3E-05	1.5E-09	2.3E-05
CR--51	76	1.0E-04	3.1E-11	3.1E-06
CE-141	76	4.5E-05	4.9E-11	1.1E-06
I--129	129	5.2E-07	1.1E-13	2.1E-07
PU-239	174	4.9E-05	4.2E-12	8.6E-08
CS-135	52	1.7E-04	3.7E-12	2.2E-08
CS-136	46	3.7E-06	3.1E-14	4.4E-09
PB--86	76	1.9E-05	1.1E-13	5.4E-09

TABLE 41 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY
TABLE 42 -- CASE I-I -- SANITARY LANDFILL - EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS
TABLE 46 -- CASE I-J -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO WORKERS AFTER J DECAY
TABLE 52 -- CASE I-K -- SANITARY LANDFILL - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS
TABLE 61 -- CASE II-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER .5 YEARS DECAY
TABLE 76 -- CASE II-K -- FILL WANTED - GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY
TABLE 134 -- CASE III-D -- SANITARY LANDFILL - INHALATION DURING SITE EXCAVATION AFTER 5 YRS
TABLE 124 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER NO DECAY
TABLE 127 -- CASE IV-E -- FILL WANTED DISPOSAL - CHILD EATS WASTE AFTER 0.1 YEARS DECAY
TABLE 129 -- CASE IV-F -- FILL WANTED DISPOSAL - FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY

REFERENCES

- Ba 73 Barton, C.J. et.al, Contribution of Radon in Natural Gas to the Natural Radioactivity Dose in Homes, ORNL-TM-4154, Oak Ridge National Laboratory (1973).
- BEIR 72 Advisory Committee on the Biological Effects of Ionizing Radiations. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation, NSA-NRC (November, 1972).
- EPA 76 Code of Federal Regulations, Title 40, Part 141, "Interim Primary Drinking Water Regulations," (July 9, 1976).
- EPA 77 Environmental Protection Agency, Federal Register, 42 no. 230, pp. 60956-60959 (November 30, 1977).
- Fla 77 Study of Radon Daughter Concentrations in Structures in Polk and Hillsborough Counties, State of Florida, Dept. Hlth & Rehab. Svc., Rad. Hlth Svc. (draft Nov. 1977).
- Gi 72 Gitlin, J.N., "Preliminary Dose Estimates from the USPHS 1970 X-ray Exposure Study," paper presented at 49th Annual Meeting of the American College of Radiology (April 6, 1972).
- IC 73 International Commission on Radiological Protection, Implications of Commission Recommendations that Doses be kept as Low as Readily Achievable, ICRP Publication 22, p. 6 (1973).
- NC 75 National Council on Radiation Protection and Measurements, Natural Background Radiation in the United States, NCRP Report No. 45 (November 1975).
- NC 75a National Council on Radiation Protection and Measurements, Review of the Current State of Radiation Protection Philosophy, NCRP Report No. 43 (January, 1975).
- NRC 76 Nuclear Regulatory Commission Calculation of Releases of Radioactive Material in Gaseous and Liquid Effluent from Pressurized Water Reactors PWR-GALE Code, NUREG-0017, NRC Off. Stds, Development (April 1976).
- Oa 72 Oakley, D.T., Natural Radiation Exposure in the United States, PhD dissertation, also printed by USEPA as ORP/SID 72-1 (June, 1972).
- Ra 64 Radford, E.P. Jr, & Hunt, V.R., "Polonium-210: A Volatile Radio-element in Cigarettes," Science, 143, 247 (1964).
- Sh 76 Shleien, B., et al., The Mean Active Bone Marrow Dose from Dose from Diagnostic Radiology, FDA-77-8013, Bu. Rad. Hlth. (April 1976).
- Un 72 United Nations Scientific Committee on the Effects of Atomic Radiation, Ionizing Radiation: Levels and Effects, 1, United Nations (1972).

- Wi 77 Windham, S.T., et.al, The Effects of Home Ventilation Systems on Indoor Radon-Radon Daughter Levels, USEPA Office of Radiation Programs (1977).
- RG 1.109 Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," US Nuclear Regulatory Commission (March, 1976).
- Ye 72 Yeates, D.B. et.al., "Natural Radiation in the Urban Environment," Nuclear Safety, 13, 4, 275-286 (July-Aug., 1972).

APPENDIX A

EQUATIONS USED TO DETERMINE THE DOSE RATE FROM EACH NUCLIDE FOR EACH PATHWAY

Symbol Definitions

$\sum_{n=1}^k$	indicates that the dose rate is summed over the contributions from the nuclide and its daughters
A_b	is the vegetation consumption rate of the meat animal (kg/day)
A_m	is the vegetation consumption rate of the milk cow (kg/day)
B_{fn}	is the bioaccumulation factor for fish for the n-th nuclide (pCi/kg)/(pCi/liter)
B_{sn}	is the bioaccumulation factor for shellfish for the n-th nuclide (pCi/kg)/(pCi/liter)
C_{nt}	is the activity concentration of the n-th nuclide in the chain at the time of exposure t (pCi/gm)
D	is the dose rate resulting from a nuclide and its associated daughter products (mrem/yr)
DF_{1nj}	is the ingestion dose factor for the n-th nuclide and the j-th age group (mrem/pCi ingested)
DF_{2nj}	is the inhalation dose factor for the n-th nuclide and the j-th age group (mrem/pCi inhaled)
DF_{3n}	is the dose factor for a 55 gallon drum containing a solution of water and nuclide n (mrem/hr)/(pCi/gm)
DF_{4n}	is the dose factor for a semi-infinite medium of density 1 g/cc containing a uniformly distributed source of nuclide n (mrem/hr)/(pCi/gm)
E	is the quantity of soil eaten by child (g/yr)
F	is the fraction of waste which is spilled

- G is the erosion rate ($\text{g/m}^2/\text{yr}$)
- H is the erosion area (m^2)
- I_{nat} is the inventory of nuclide n after a year of disposing waste at the site followed by t years of decay in transit to the watercourse (pCi)
- K is the concentration of waste in the air (g/cubic meter)
- L_n is the leach rate from the waste inventory (per year)
- $Q_{\text{fm}} = 1000 \frac{\text{gm}}{\text{kg}} * S_{\text{vn}} * (U_v + U_m * A_m * S_{\text{mn}} + U_b * A_b * S_{\text{bn}})$
- $\frac{\text{gm}}{\text{yr}} = \frac{\text{gm}}{\text{kg}} * 1 * \left(\frac{\text{kg}}{\text{yr}} + \frac{\text{kg}}{\text{yr}} * \frac{\text{kg}}{\text{day}} * \frac{\text{days}}{\text{kg}} + \frac{1}{\text{yr}} * \frac{\text{kg}}{\text{day}} * \frac{\text{days}}{1} \right)$
is the equivalent intake of vegetation in gms/yr through the food pathway (fruits and vegetables, milk, and meat)
- $Q_{\text{wn}} = (U_w + U_f * B_{\text{fn}} + U_s * B_{\text{sn}}) * 1000 \text{ cc/liter}$
- $\frac{\text{cc}}{\text{yr}} = \left(\frac{1}{\text{yr}} + \frac{\text{kg}}{\text{yr}} * \frac{1}{\text{kg}} + \frac{\text{kg}}{\text{yr}} * \frac{1}{\text{kg}} * \frac{\text{cc}}{1} \right)$
the equivalent intake of water through the watercourse pathways (includes drinking water, fish and shellfish)
- R is the waste density (gm/cc)
- S_{bn} is the stable element transfer factor for meat (days/kg)
- S_{mn} is the stable element transfer factor for milk (days/liter)
- S_{vn} is the stable element transfer factor for vegetation (pCi/gm vegetation)/(pCi/gm soil)
- T_b is the duration of burial (years)
- T_x is the duration of exposure (hrs/yr)
- U_a is the breathing rate of the individual under consideration (cubic meters/yr)

- U_b is the consumption rate of meat for the individual under consideration (kg/yr)
- U_f is the consumption rate of fish for the individual under consideration (kg/yr)
- U_m is the consumption rate of milk for the individual under consideration (liters/yr)
- U_s is the consumption rate of shellfish for individual under consideration (kg/yr)
- U_v is the consumption rate of fruits and vegetables for the individual under consideration (kg/yr)
- U_w is the consumption rate of water for the individual under consideration (liters/yr)
- V is the waste disposal rate (cc/yr)
- W is the flow rate in the watercourse (cc/yr)

Exposure Pathways

Pathway A - Leach into Watercourse

$$D = \frac{1}{W} \sum_{n=1}^k Q_{wn} * DF_{lnj} * I_{nat} * L_n$$

$$\frac{mrem}{yr} = \frac{1}{\frac{cc}{yr}} * \frac{cc}{yr} * \frac{mrem}{pCi} * pCi * \frac{1}{yr}$$

Pathway B - Spillage into Watercourse

$$D = \frac{F * V * R}{W} \sum_{n=1}^k Q_{wn} * DF_{lnj} * C_{nt}$$

$$\frac{mrem}{yr} = \frac{1 * \frac{cc}{yr} * \frac{gm}{cc} * \frac{cc}{yr} * \frac{mrem}{pCi} * \frac{pCi}{gm}}{\frac{cc}{yr}}$$

Pathways C - Inhalation of Spilled waste

and D - Inhalation of Waste During Excavation

$$D = K * U_a * T_x \sum_{n=1}^k DF_{2nj} * C_{nt}$$

$$\frac{mrem}{yr} = \frac{gm}{m^3} * \frac{m^3}{hr} * \frac{hr}{yr} * \frac{mrem}{pCi} * \frac{pCi}{gm}$$

Pathway E - Child Eats Dirt on Waste Site

$$D = E * \sum_{n=1}^k DF_{lnj} * C_{nt}$$

$$\frac{mrem}{yr} = \frac{gm}{yr} * \frac{mrem}{pCi} * \frac{pCi}{gm \text{ soil}}$$

Pathway F - Food Grown on Waste Site

$$D = \sum_{n=1}^k Q_{fm} * DF_{lnj} * C_{nt}$$

$$\frac{mrem}{yr} = \frac{gm}{yr} * \frac{mrem}{pCi} * \frac{pCi}{gm}$$

Pathway G - Erosion of Waste into Watercourse

$$D = \frac{G * H}{W} \sum_{n=1}^k Q_{wn} * DF_{lnj} * C_{nt}$$

$$\frac{mrem}{yr} = \frac{\left(\frac{gms}{2} - yr\right) * m^2}{\frac{cc}{yr}} * \frac{cc}{yr} * \frac{mrem}{pCi} * \frac{pCi}{gm}$$

Pathway H - Inhalation of Eroded Waste

same as pathways C and D

Pathway I - Direct Irradiation from 55 Gallon Drums

$$D = T_x \sum_{n=1}^k DF_{3n} * C_{nt}$$

$$\frac{\text{mrem}}{\text{yr}} = \frac{\text{hrs}}{\text{yr}} * \frac{\text{mrem/hr}}{\text{pCi/gm}} * \frac{\text{pCi}}{\text{gm}}$$

Pathways J and K - Direct Irradiation from Ground Surface

$$D = T_x \sum_{n=1}^k DF_{4n} * C_{nt}$$

$$\frac{\text{mrem}}{\text{yr}} = \frac{\text{hrs}}{\text{yr}} * \frac{\text{mrem/hr}}{\text{pCi/gm}} * \frac{\text{pCi}}{\text{gm}}$$

Note: For this pathway C_{nt} continues to decay during the exposure time.

APPENDIX B

COMPUTED RESULTS OF DISPOSAL SCENARIO-PATHWAY EVALUATIONS

Tables representing 15 of the most restrictive exposure pathways identified in Tables 4-4 and 4-6 are included in this appendix. The complete set of 143 tables are on file at the Atomic Industrial Forum.

TABLE 25

CASE I-E -- SANITARY LANDFILL - CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS				
ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+11 YRS	3.3E-01		
C---14	5.73E+13 YRS	2.2E-02		
NA--24	1.50E+01 HRS	1.0E+07		
F---32	1.43E+01 DYS	1.0E+07		
CF--51	2.78E+01 DYS	1.0E+07		
MN--56	3.12E+02 DYS	3.3E+00		
MN--56	2.53E+00 HRS	1.0E+07		
FE--59	2.40E+00 YRS	2.9E-02		
FE--59	4.50E+01 DYS	1.0E+07		
CO--58	7.10E+01 DYS	4.9E+05		
CO--60	5.24E+00 YRS	6.2E-03		
NI--59	8.11E+04 YRS	3.1E-02		
NI--63	9.21E+01 YRS	1.2E-02		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	1.3E+00		
ZN--69	5.50E+01 MIN	1.0E+07		
RP--82	2.41E+00 HRS	1.0E+07		
RP--84	3.20E+01 MIN	1.0E+07		
RP--85	3.60E+00 MIN	1.0E+07		
RB--86	1.87E+01 DYS	1.0E+07		
FR--98	1.80E+01 MIN	1.0E+07		
SR--99D	1.50E+01 MIN	1.0E+07	SR--89	100.
SR--89	5.06E+01 DYS	1.0E+07		
SR--90	2.88E+01 YRS	1.3E-05		
SR--91D	9.70E+00 HRS	1.0E+07	Y---91	100.
SP--92	2.70E+00 HRS	1.0E+07		
Y---91	2.67E+00 DYS	1.0E+07		
Y--91D	5.00E+01 MIN	1.0E+07	Y---91	100.
Y---91	5.90E+01 DYS	1.0E+07		
Y---92	3.53E+00 HRS	1.0E+07		
Y---93D	1.02E+01 HRS	1.0E+07	NB-93M	52.
Zr--93D	1.50E+06 YRS	2.2E+01	NB-93M	52.
Zr--95D	6.50E+01 DYS	1.0E+07	NB--95	38.
Zr--97	1.70E+01 HRS	1.0E+07		
NB-93M	3.71E+00 YRS	6.2E+01		
NR--95	3.50E+01 DYS	1.0E+07		
NB--97	1.20E+00 HRS	1.0E+07		
MO--99D	2.79E+00 DYS	1.0E+07	TC--99	100.
TC-99D	6.00E+00 HRS	1.0E+07	TC--99	100.
TC--99	2.11E+05 YRS	1.0E+00		
PU-103	4.00E+01 DYS	1.0E+07		
PU-105	4.43E+00 HRS	1.0E+07		
RU-106	1.00E+00 YRS	1.1E+00		
RM-105	1.50E+00 DYS	1.0E+07		
AG110M	2.60E+02 DYS	7.4E+01		
TE125M	5.80E+01 DYS	1.0E+07		
TE127M+D	1.05E+02 DYS	9.3E+03	TE-127	10.
TE-127	9.30E+00 HRS	1.0E+07		
TE129MD	3.40E+01 DYS	2.3E+05	I--129	100.

TABLE 25

CASE I-E -- SANITARY LANDFILL -
CHILD EATS DIRT ON WASTE SITE AFTER 5 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+00 HRS	1.0E+07	I--129	100.
TE-131MD	1.20E+00 DYS	1.0E+07	I--131	100.
TE-131D	2.50E+01 MIN	1.0E+07	I--131	100.
TE-132+D	3.25E+00 DYS	1.0E+07	I--132	4.
I--129	1.60E+07 YRS	1.3E-03		
I--131	1.24E+01 HRS	1.0E+07		
I--131	8.05E+00 DYS	1.0E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	1.0E+07		
CS-134	2.10E+00 YRS	3.2E-03	CS-135	100.
CS-135	2.0E+06 YRS	6.3E-03		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137	3.0E+01 YRS	1.2E-03		
CS-138	3.22E+01 MIN	1.0E+07		
BA-140	1.28E+01 DYS	1.0E+07		
BA-141D	1.80E+01 MIN	1.0E+07	CE-141	100.
BA-142	1.10E+01 MIN	1.0E+07		
LA-141	1.67E+00 DYS	1.0E+07		
LA-141D	3.90E+00 HRS	1.0E+07	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143D	1.37E+00 DYS	1.0E+07	PF-143	100.
CE-144	2.85E+02 DYS	3.7E+01		
PR-143	1.37E+01 DYS	1.0E+07		
PR-144	1.73E+01 MIN	1.0E+07		
NO-147D	1.11E+01 DYS	5.6E+03	PM-147	100.
PM-147	2.60E+00 YRS	6.6E+01		
W--147	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	2.3E-07		
AC-227+D	2.16E+01 YRS	5.0E-05	RA-223	90.
TH-227D	1.92E+01 DYS	1.0E+07	RA-223	100.
PA-231+D	3.25E+04 YRS	1.6E-04	RA-223	44.
U--235	7.13E+08 YRS	1.0E-03		
NP-239D	2.35E+00 DYS	5.8E+03	PU-239	100.
PU-239	2.44E+04 YRS	1.5E-03		

BASED ON: A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR TO CHILDREN
WHO EAT .10 KG OF DIRT IN A GIVEN YEAR
DECAY TIME FROM BURIAL TO INGESTION = 5.0E+00 YEARS
FRACTION OF SOIL WHICH IS WASTE = .20

TABLE 29

CASE I-F -- SANITARY LANDFILL -
FOOD GROWN ON WASTE SITE AFTER 5 YEARS

ISOTOPE	HALF-LIFE		LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS		6.6E-05		
C---14	5.73E+03 YRS		9.1E-06		
NA--24	1.50E+01 HRS		1.0E+07		
P---32	1.43E+01 DYS		1.0E+07		
CP--51	2.78E+01 DYS		1.0E+07		
MN--54	3.12E+02 DYS		1.5E-01		
MN--56	2.58E+00 HRS		1.0E+07		
FE--55	2.40E+00 YRS		4.6E-02		
FE--59	4.50E+01 DYS		1.0E+07		
CO--58	7.1E+01 DYS		2.1E-05		
CO--60	5.24E+00 YRS		2.5E-03		
NI--59	8.71E+04 YRS		1.3E-03		
NI--63	9.21E+01 YRS		4.9E-04		
NI--65	2.56E+01 HRS		1.0E+07		
CU--64	1.29E+01 HRS		1.0E+07		
ZN--65	2.43E+02 DYS		8.5E-04		
ZN--69	5.50E+01 MIN		1.0E+07		
BR--83	2.40E+00 HRS		1.0E+07		
BR--84	3.20E+01 MIN		1.0E+07		
BR--85	3.10E+00 MIN		1.0E+07		
FB--86	1.87E+01 DYS		1.0E+07		
CR--88	1.80E+01 MIN		1.0E+07		
BR--89D	1.50E+01 MIN		1.0E+07	SC--89	100.
SR--89	5.06E+01 DYS		1.0E+07		
SE--90	2.89E+01 YRS		2.2E-06		
SA--91D	9.70E+00 HRS		1.0E+07	Y---91	100.
SE--92	2.70E+00 HRS		1.0E+07		
Y---90	2.67E+00 DYS		1.0E+07		
Y--91MD	5.00E+01 MIN		1.0E+07	Y---91	100.
Y---91	5.90E+01 DYS		1.0E+07		
Y---92	3.53E+00 HRS		1.0E+07		
Y---93D	1.02E+01 HRS		1.0E+07	NB--93M	99.
ZR--93D	1.50E+06 YRS		2.8E+00	NA--93M	99.
ZR--95D	6.50E+01 DYS		1.0E+07	NB--95	99.
ZR--97	1.7E+01 HRS		1.0E+07		
NB--93M	3.70E+01 YRS		3.9E+00		
NA--95	3.50E+01 DYS		1.0E+07		
NB--97	1.20E+00 HRS		1.0E+07		
MO--99D	2.79E+00 DYS		2.9E+04	TC--99	100.
TC--99MD	6.00E+00 HRS		3.2E+05	TC--99	100.
TC--99	2.10E+05 YRS		1.1E-03		
RU-103	4.00E+01 DYS		1.0E+07		
RU-105	4.43E+00 HRS		1.0E+07		
RU-106	1.00E+00 YRS		5.0E-02		
RH-105	1.50E+01 DYS		1.0E+07		
AG111M	2.60E+02 DYS		1.1E-01		
TE125M	5.80E+01 DYS		3.1E+05		
TE127M+D	1.05E+02 DYS		7.4E+00	TE-127	3.
TE-127	9.30E+00 HRS		1.0E+07		
TE129MD	3.40E+01 DYS		3.9E+04	I--129	100.

TABLE 29

CASE I-F -- SANITARY LANDFILL --
FOOD GROWN ON WASTE SITE AFTER 5 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+00 HRS	1.0E+07	I--129	100.
TE-131D	1.23E+00 DYS	1.0E+07	I--131	100.
TE-131D	2.53E+01 MIN	1.0E+07	I--131	100.
TE-132	3.25E+00 DYS	1.0E+07		
I--129	1.63E+07 YRS	2.2E-04		
I--131	1.24E+01 HRS	1.0E+07		
I--131	9.5E+00 DYS	1.0E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.7E+00 HRS	9.7E+05	CS-135	100.
CS-134	2.10E+00 YRS	1.3E-04		
CS-135	2.10E+00 YRS	3.7E-04		
CS-136	1.3E+00 DYS	1.0E+07		
CS-137	3.00E+01 YRS	4.6E-05		
CS-138	3.22E+01 MIN	1.0E+07		
RA-141	1.28E+01 DYS	1.0E+07		
RA-141D	1.90E+01 MIN	1.0E+07	CE-141	100.
RA-142	1.10E+01 MIN	1.0E+07		
LA-141	1.67E+00 DYS	1.0E+07		
LA-141D	3.9E+00 HRS	1.0E+07	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143D	1.37E+00 DYS	1.0E+07	PR-143	100.
CE-144	2.85E+02 DYS	8.1E+01		
PR-143	1.37E+00 DYS	1.0E+07		
FR-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	2.9E+03	DM-147	100.
FM-147	2.63E+00 YRS	3.5E+01		
W--147	2.43E+00 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	5.0E-07		
AC-227+D	2.16E+01 YRS	8.4E-05	RA-223	64.
TH-227D	1.82E+01 DYS	1.0E+07	RA-223	100.
PA-231+D	3.25E+04 YRS	1.0E-04	RA-223	13.
U--235	7.10E+08 YRS	5.2E-04		
NP-239D	2.35E+00 DYS	5.4E+04	PU-239	100.
PU-239	2.44E+04 YRS	1.4E-02		

BASED ON: CONSUMPTION OF FOOD GROWN ON WASTE SITE
A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR TO ADULTS
DECAY TIME FROM BURIAL TO INGESTION = 5.0E+00 YEARS
CONSUMPTION OF 150. KG OF FRUITS AND VEGETABLES PER YEAR
CONSUMPTION OF 310. LITERS OF MILK PER YEAR
CONSUMPTION OF 11. KG OF MEAT PER YEAR
CONSUMPTION RATE OF COW = 50. KG/DAY
CONSUMPTION RATE OF CATTLE = 50. KG/DAY
FRACTION OF SOIL WHICH IS WASTE = .10

TABLE 41

CASE I-I -- SANITARY LANDFILL --
EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.3E+07		
C---14	5.73E+03 YRS	8.2E-02		
NA--24	1.50E+01 HRS	2.9E-06		
P---32	1.43E+01 DYS	1.6E-04		
CR--51	2.78E+01 DYS	2.2E-04		
4N--54	3.12E+02 DYS	1.2E-05		
MN--56	2.53E+00 HRS	5.9E-06		
FE--55	2.40E+00 YRS	1.0E+07		
FE--59	4.50E+01 DYS	9.0E-06		
CO--58	7.17E+01 DYS	9.4E-06		
CO--60	5.24E+03 YRS	4.5E-06		
NI--59	8.01E+04 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.0E+07		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	3.8E-05		
ZN--65	2.43E+02 DYS	1.0E-05		
7N--69	5.50E+01 MIN	7.0E-04		
RR--83	2.40E+00 HRS	4.4E-04		
RF--84	3.20E+01 MIN	4.9E-06		
ER--85	3.00E+03 MIN	8.3E-05		
RB--86	1.87E+01 DYS	7.1E-05		
EB--88	1.80E+01 MIN	1.1E-05		
EG--89	1.50E+01 MIN	4.0E-06		
SP--89	5.06E+01 DYS	2.3E-04		
SR--91	2.88E+01 YRS	2.5E-03		
SE--91	9.70E+00 HRS	1.3E-05		
SR--92	2.70E+00 HRS	7.9E-06		
Y---91	2.67E+00 DYS	1.0E-04		
Y--91M	5.00E+01 MIN	1.3E-05		
Y---91	5.90E+01 DYS	3.0E-04		
Y---92	3.53E+00 HRS	2.3E-05		
Y---93	1.02E+01 HRS	3.4E-05		
ZR--93	1.50E+06 YRS	3.2E+01		
ZF--95	6.50E+01 DYS	1.2E-05		
ZF--97	1.70E+01 HRS	4.7E-05		
NB-93M	3.70E+00 YRS	5.7E-01		
NB--95	3.50E+01 DYS	1.2E-05		
NB--97	1.20E+00 HRS	1.2E-05		
MO--99	2.79E+00 DYS	5.8E-05		
TC-99M	6.00E+01 HRS	8.7E-05		
TC--99	2.10E+05 YRS	1.3E-02		
RU-103	4.00E+01 DYS	1.5E-05		
RU-115	4.43E+00 HRS	1.2E-05		
RU-116	1.00E+00 YRS	4.4E+03		
RH-105	1.50E+00 DYS	8.7E-05		
AG110M	2.60E+02 DYS	3.7E-06		
TE125M	5.80E+01 DYS	2.3E-02		
TE127M	1.05E+02 DYS	1.8E-01		
TE-127	9.30E+00 HRS	1.1E-03		
TE129M	3.40E+01 DYS	1.9E-04		

TABLE 41

CASE I-I -- SANITARY LANDFILL -
EXPOSURE TO 55 GALLON DRUMS AFTER NO DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+00 HRS	6.3E-05		
TE-131M	1.20E+00 DYS	8.1E-06		
TE-131	2.50E+01 MIN	2.2E-05		
TE-132	3.25E+00 DYS	3.9E-05		
I--129	1.60E+07 YRS	2.2E-02		
I--130	1.24E+01 HRS	3.9E-06		
I--131	8.05E+00 DYS	2.1E-05		
I--132	2.30E+00 HRS	3.7E-06		
I--133	2.10E+01 HRS	1.5E-05		
I--134	5.30E+01 MIN	4.9E-06		
I--135	6.70E+00 HRS	5.9E-06		
CS-134	2.10E+00 YRS	5.2E-06		
CS-135	2.00E+06 YRS	3.6E-02		
CS-136	1.30E+01 DYS	4.6E-06		
CS-137	3.10E+01 YRS	2.2E-03		
CS-138	3.22E+01 MIN	4.7E-06		
BA-140	1.28E+01 DYS	3.2E-05		
BA-141	1.80E+01 MIN	1.8E-05		
BA-142	1.10E+01 MIN	1.5E-05		
LA-141	1.67E+01 DYS	5.3E-06		
LA-142	3.90E+00 HRS	7.4E-05		
CE-141	1.40E+00 HRS	5.2E-06		
CE-143	3.25E+01 DYS	1.6E-04		
CE-144	1.37E+00 DYS	2.9E-05		
CE-144	2.35E+02 DYS	6.6E-04		
PR-143	1.37E+01 DYS	1.2E-05		
PR-144	1.73E+01 MIN	5.2E-05		
NO-147	1.11E+01 DYS	5.7E-05		
PM-147	2.60E+00 YRS	2.9E-02		
W--147	2.40E+01 HRS	1.9E-05		
FA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	2.0E-03		
AC-227	2.16E+01 YRS	7.9E-03		
TH-227	1.82E+01 DYS	1.0E+07		
PA-231	3.25E+04 YRS	1.0E+07		
U--235	7.10E+08 YRS	1.0E+07		
NP-239	2.35E+00 DYS	1.0E+07		
PU-239	2.44E+04 YRS	6.8E-01		

BASED ON: EXTERNAL EXPOSURE TO 55 GALLON DRUM OF WASTE
A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR
EXPOSURE TIME = 1.6E+02 HOURS/YEAR
DECAY TIME PRIOR TO EXPOSURE = C. YEARS
WASTE DENSITY = 1.0 GM/CC

TABLE 42

CASE I-I -- SANITARY LANDFILL -				
EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS				
ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.0E+07		
C---14	5.73E+03 YRS	8.2E-02		
NA--24	1.50E+01 HRS	4.3E-06		
P---32	1.43E+01 DYS	1.7E-04		
CF--51	2.78E+01 DYS	2.2E-04		
MN--54	3.12E+02 DYS	1.2E-05		
MN--56	2.58E+00 HRS	6.3E-05		
FE--55	2.40E+00 YRS	1.0E+07		
FE--59	4.50E+01 DYS	9.1E-06		
CO--58	7.10E+01 DYS	9.4E-06		
CO--60	5.24E+00 YRS	4.5E-06		
NI--59	8.01E+04 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.0E+07		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	6.0E-05		
ZN--65	2.43E+02 DYS	1.7E-05		
ZN--69	5.50E+01 MIN	5.3E-01		
RE--83	2.40E+00 HRS	5.5E-03		
RE--84	3.20E+01 MIN	4.3E-01		
RE--85	3.00E+00 MIN	2.1E-02	KR-85M	100.
RE--86	1.87E+01 DYS	7.2E-05		
RE--88	1.80E+01 MIN	6.9E+03		
RE--89	1.50E+01 MIN	1.1E+00	SE--89	100.
SR--89	5.0E+01 DYS	2.3E-04		
SE--90+0	2.88E+01 YRS	7.7E-04	Y---90	69.
SE--91+0	9.70E+00 HRS	1.4E-05	Y--91M	39.
SE--92+0	2.70E+00 HRS	4.2E-05	Y---92	44.
Y---91	2.67E+00 DYS	1.1E-04		
Y--91M+0	5.00E+01 MIN	1.4E-02	Y---91	3.
Y---91	5.90E+01 DYS	3.0E-04		
Y---92	3.53E+00 HRS	1.3E-04		
Y---93	1.02E+01 HRS	6.1E-05		
ZR--93	1.50E+06 YRS	3.2E+01		
TE--95	6.50E+01 DYS	1.2E-05		
ZR--97+0	1.70E+01 HRS	7.5E-06	NB--97	49.
NB-97M	3.70E+00 YRS	5.7E-01		
NB--95	3.50E+01 DYS	1.2E-05		
NB--97	1.20E+00 HRS	1.8E-03		
MO--99+0	2.79E+00 DYS	4.6E-05	TC-99M	28.
TC-99M	6.00E+00 HRS	2.4E-04		
TC--99	2.10E+05 YRS	1.3E-02		
RU-103	4.00E+01 DYS	1.6E-05		
RU-105+0	4.43E+00 HRS	4.4E-05	RH-105	4.
FU-106	1.00E+00 YRS	2.2E-05	RH-106	100.
RH-105	1.50E+00 DYS	1.0E-04		
AG110M	2.60E+02 DYS	3.7E-06		
TE125M	5.80E+01 DYS	2.3E-02		
TE127M+0	1.05E+02 DYS	2.2E-03	TE-127	99.
TE-127	9.30E+00 HRS	2.0E-03		
TE129M+0	3.40E+01 DYS	4.8E-05	TE-129	75.

TABLE 42

CASE I-I -- SANITARY LANDFILL -
EXPOSURE TO 55 GALLON DRUMS AFTER 0.001 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+00 HRS	1.5E-02		
TE-131M+D	1.20E+00 DYS	9.2E-06	TE-131	7.
TS-131D	2.51E+01 MIN	1.1E-02	I--131	100.
TE-132+D	3.25E+00 DYS	3.9E-06	I--132	91.
I--129	1.40E+07 YRS	2.2E-02		
I--131	1.24E+01 HRS	6.3E-06		
I--131	9.05E+00 DYS	2.2E-05		
I--132	2.30E+00 HRS	5.2E-05		
I--133	2.10E+01 HRS	2.1E-05		
I--134	5.30E+01 MIN	4.7E-03		
I--135+D	6.71E+00 HRS	1.2E-05	XE-135	11.
CS-134	2.10E+00 YRS	5.2E-06		
CS-135	2.11E+00 YRS	3.6E-02		
CS-136	1.30E+01 DYS	4.7E-06		
CS-137+D	3.00E+01 YRS	1.3E-05	SA137M	99.
CS-138	3.22E+01 MIN	3.9E-01		
PA-140+D	1.28E+01 DYS	1.7E-05	LA-140	48.
PA-141D	1.80E+01 MIN	4.2E-03	LA-141	99.
PA-142D	1.10E+01 MIN	2.7E-03	LA-142	100.
LA-141	1.67E+00 DYS	5.8E-06		
LA-141	3.91E+00 HRS	3.5E-04		
LA-142	1.40E+00 HRS	4.0E-04		
CE-141	3.25E+01 DYS	1.6E-04		
CE-143+D	1.37E+00 DYS	3.4E-05	PR-143	5.
CE-144+D	2.85E+02 DYS	4.4E-05	PR-144	93.
PR-143	1.37E+01 DYS	1.2E-05		
PR-144	1.73E+01 MIN	7.2E-04		
ND-147	1.11E+01 DYS	5.3E-05		
PM-147	2.60E+00 YRS	2.9E-02		
W--187	2.40E+01 HRS	2.4E-05		
KA-223	1.14E+01 DYS	1.1E-07		
FA-226	1.60E+03 YRS	2.0E-03		
AC-227	2.16E+01 YRS	7.8E-03		
TH-227+D	1.82E+01 DYS	1.0E-07	RA-223	2.
PA-231D	3.25E+04 YRS	2.4E+02	AC-227	100.
U--235	7.11E+08 YRS	1.0E+07		
NP-239D	2.35E+00 DYS	1.0E+07	PU-239	100.
PU-239	2.44E+04 YRS	6.9E-01		

BASED ON: EXTERNAL EXPOSURE TO 55 GALLON DRUM OF WASTE
A MAXIMUM DOSE COMMITMENT OF 1.00 MR/HR
EXPOSURE TIME = 1.0E+02 HOURS/YEAR
DECAY TIME PRIOR TO EXPOSURE = 1.0E-03 YEARS
WASTE DENSITY = 1.0 GM/CC

TABLE 46

CASE I-J -- SANITARY LANDFILL -				
GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY				
ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.3E+07		
C---14	5.73E+03 YRS	1.8E-03		
NA--24	1.50E+01 HRS	8.1E-06		
P---32	1.43E+01 DYS	4.9E-05		
CR--51	2.78E+01 DYS	1.8E-04		
MN--56	3.12E+02 DYS	8.7E-06		
MN--56	2.58E+00 HRS	1.3E-04		
FE--55	2.4E+00 YRS	1.3E+07		
FE--59	4.5E+01 DYS	6.4E-06		
CO--58	7.1E+01 DYS	7.2E-06		
CO--60	5.24E+00 YRS	3.2E-06		
NI--59	8.0E+04 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.3E+07		
NI--65	2.56E+00 HRS	1.3E+07		
CU--64	1.29E+01 HRS	1.5E-04		
ZN--65	2.43E+02 DYS	1.2E-05		
ZN--69	5.50E+01 MIN	6.1E-03		
BR--83+0	2.4E+00 HRS	2.4E-03	KR-83M	2.
BR--84	3.2E+01 MIN	3.7E-04		
BR--85+0	3.0E+00 MIN	1.7E-02	KR-85M	34.
BR--86	1.87E+01 DYS	2.6E-05		
FR--88	1.8E+01 MIN	1.1E-03		
FR--89	1.5E+01 MIN	8.1E-04		
SR--89	5.0E+01 DYS	4.4E-05		
SR--90+0	2.88E+01 YRS	4.2E-05	Y---90	77.
SR--91+0	9.7E+00 HRS	3.7E-05	Y---91M	32.
SR--92+0	2.70E+00 HRS	8.1E-05	Y---92	36.
Y---90	2.67E+00 DYS	3.4E-05		
Y---91M	5.0E+01 MIN	7.9E-04		
Y---91	5.90E+01 DYS	5.0E-05		
Y---92	3.53E+00 HRS	1.7E-04		
Y---93	1.02E+01 HRS	8.3E-05		
ZR--93	1.5E+06 YRS	3.2E-02		
ZR--95+0	6.5E+01 DYS	8.7E-06	NB--95	4.
ZR--97+0	1.70E+01 HRS	1.4E-05	NB--97	45.
NB-93M	3.7E+00 YRS	1.3E-04		
NB--95	3.5E+01 DYS	9.0E-06		
NB--97	1.2E+00 HRS	4.4E-04		
MO--99+0	2.79E+00 DYS	3.3E-05	TC-99M	25.
TC-99M	6.0E+00 HRS	8.2E-04		
TC--99	2.1E+05 YRS	5.7E-04		
RU-113	4.8E+01 DYS	1.2E-05		
RU-105+0	4.43E+00 HRS	1.1E-04	RH-105	11.
RU-106	1.0E+00 YRS	8.3E-06	RH-106	100.
RH-105	1.5E+00 DYS	1.2E-04		
AG116M	2.6E+02 DYS	2.7E-06		
TE125M	5.4E+01 DYS	1.9E-03		
TE127MD	1.15E+02 DYS	1.4E-04	TE-127	100.
TE-127	9.3E+00 HRS	9.1E-04		
TE129M+0	3.4E+01 DYS	2.3E-05	TE-129	82.

TABLE 46

CASE I-J -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO WORKERS AFTER 0 DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+14 HRS	1.7E-13		
TE-131+D	1.20E+00 DYS	1.3E-05	TE-131	8.
TE-131+D	2.50E+01 MIN	1.6E-03	I--131	18.
TE-132+D	3.25E+00 DYS	3.7E-06	I--132	92.
I--129	1.60E+07 YRS	1.1E-03		
I--130	1.24E+01 HRS	1.6E-05		
I--131	8.05E+00 DYS	1.4E-05		
I--132	2.30E+00 HRS	7.9E-05		
I--133+D	2.10E+01 HRS	3.1E-05	XE-133	2.
I--134	5.30E+01 MIN	2.6E-04		
I--135+D	6.70E+00 HRS	3.2E-05	XE-135	15.
CS-134	2.10E+00 YRS	3.9E-06		
CS-135	2.00E+06 YRS	1.2E-03		
CS-136	1.31E+01 DYS	3.7E-06		
CS-137+D	3.00E+01 YRS	9.1E-06	GA137M	95.
CS-138	3.22E+01 MIN	3.7E-04		
BA-141+D	1.28E+01 DYS	5.1E-06	LA-140	77.
BA-141+D	1.80E+01 MIN	1.4E-03	LA-141	32.
BA-142+D	1.10E+01 MIN	8.7E-04	LA-142	79.
LA-140	1.67E+00 DYS	6.7E-06		
LA-141+D	3.90E+00 HRS	3.2E-04	CE-141	2.
LA-142	1.40E+01 HRS	1.5E-04		
CE-141	3.25E+01 DYS	6.8E-05		
CE-143+D	1.37E+00 DYS	2.8E-05	PR-143	34.
CE-144+D	2.85E+02 DYS	1.3E-05	PK-144	96.
PR-143	1.37E+01 DYS	4.8E-06		
PR-144	1.73E+01 MIN	3.3E-03		
ND-147	1.11E+01 DYS	3.7E-05		
PM-147	2.60E+00 YRS	9.9E-04		
M--187	2.40E+01 HRS	4.0E-05		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	1.6E-03		
AC-227	2.16E+01 YRS	5.1E-04		
TH-227+D	1.82E+01 DYS	1.0E+07	RA-223	11.
PA-231	3.25E+04 YRS	1.0E+07		
U--235	7.10E+08 YRS	1.0E+07		
NP-239D	2.35E+00 DYS	2.6E+06	PU-239	100.
PU-239	2.44E+04 YRS	3.0E-01		

BASED ON: EXTERNAL EXPOSURE TO BURIED WASTE
 A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR
 EXPOSURE TIME = 1.0E+02 HOURS
 DECAY TIME FROM BURIAL TO EXPOSURE = 0. YEARS
 WASTE DENSITY = 1.0 GM/CC
 FRACTION OF SOIL WHICH IS WASTE = 1.0E+00

TABLE 47

CASE I-J -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO WORKERS AFTER .001 YR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H----3	1.23E+01 YRS	1.0E+07		
C---14	5.73E+03 YRS	1.8E-03		
NA--24	1.50E+01 HRS	1.2E-05		
P---32	1.43E+01 DYS	5.0E-05		
CR--51	2.78E+01 DYS	1.8E-04		
MN--54	3.12E+02 DYS	8.8E-06		
MN--56	2.58E+00 HRS	1.1E-03		
FE--55	2.40E+00 YRS	1.0E+07		
FE--59	4.50E+01 DYS	6.5E-06		
CO--58	7.10E+01 DYS	7.2E-06		
CO--60	5.24E+00 YRS	3.2E-06		
NI--59	8.01E+04 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.0E+07		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	2.4E-04		
ZN--65	2.43E+02 DYS	1.2E-05		
ZN--69	5.50E+01 MIN	4.6E+00		
RR--83+D	2.40E+00 HRS	2.9E-02	KR-83M	6.
RE--84	3.20E+01 MIN	3.2E+01		
BR--85C	3.00E+00 MIN	1.9E-01	KR-95M	100.
PB--86	1.87E+01 DYS	2.0E-05		
PR--88	1.80E+01 MIN	7.0E+05		
SR--89D	1.50E+01 MIN	2.0E-01	SF--89	100.
SR--89	5.06E+01 DYS	4.0E-05		
SP--90+D	2.88E+01 YRS	3.8E-05	Y---90	79.
SP--91+D	9.70E+01 HRS	6.7E-05	Y--91M	34.
SK--92+D	2.70E+00 HRS	3.7E-04	Y---92	69.
Y---90	2.67E+00 DYS	3.8E-05		
Y--91M+D	5.00E+01 MIN	8.1E-02	Y---91	93.
Y---91	5.90E+01 DYS	5.0E-05		
Y---92	3.53E+00 HRS	9.5E-04		
Y---93	1.02E+01 HRS	1.4E-04		
ZR--93+D	1.50E+06 YRS	3.1E-02	NB-93M	4.
ZR--95+D	6.50E+01 DYS	5.6E-06	NB--95	5.
ZR--97+D	1.70E+01 HRS	2.4E-05	NB--97	47.
NB-93M	3.70E+00 YRS	1.3E-04		
NB--95	3.50E+01 DYS	9.1E-06		
NB--97	1.21E+00 HRS	7.0E-02		
MO--99+D	2.79E+00 DYS	3.5E-05	TC-99M	26.
TC-99M	6.00E+00 HRS	2.3E-03		
TC--99	2.10E+05 YRS	5.7E-04		
RU-103	4.00E+01 DYS	1.2E-05		
RU-105+D	4.43E+00 HRS	3.3E-04	RH-105	32.
RU-106C	1.00E+00 YRS	8.9E-06	RH-106	100.
RH-105	1.50E+00 DYS	1.4E-04		
AG-110M	2.60E+02 DYS	2.7E-06		
TE-125M	5.80E+01 DYS	1.9E-03		
TE-127MO	1.55E+02 DYS	1.0E-04	TE-127	100.
TE-127	9.30E+00 HRS	1.7E-03		
TE-129M+D	3.40E+01 DYS	2.3E-05	TE-129	83.

TABLE 47

CASE I-J -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO WORKERS AFTER .001 YR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+06 HRS	3.8E-01		
TE-131M+D	1.20E+06 DYS	1.6E-05	I--131	9.
TE-131C	2.50E+01 MIN	8.9E-03	I--131	100.
TE-132+D	3.25E+06 DYS	3.8E-06	I--132	92.
I--129	1.63E+07 YRS	1.1E-03		
I--130	1.24E+01 HRS	2.6E-05		
I--131	9.05E+00 DYS	1.9E-05		
I--132	2.30E+00 HRS	1.1E-03		
I--133+D	2.10E+01 HRS	4.5E-05	XE-133	2.
I--134	5.30E+01 MIN	2.5E-01		
I--135+D	6.70E+00 HRS	6.7E-05	XE-135	26.
CS-134	2.10E+00 YRS	3.3E-06		
CS-135	2.00E+06 YRS	1.2E-03		
CS-136	1.30E+01 DYS	3.8E-06		
CS-137+D	3.00E+01 YRS	9.1E-06	3A137M	95.
CS-138	3.22E+01 MIN	3.1E+01		
BA-140+D	1.28E+01 DYS	4.7E-06	LA-140	80.
BA-141D	1.80E+01 MIN	1.7E-02	LA-141	93.
SA-142D	1.10E+01 MIN	7.4E-02	LA-142	100.
LA-140	1.67E+06 DYS	7.9E-06		
LA-141+D	3.90E+00 HRS	1.4E-03	CE-141	8.
LA-142	1.40E+00 HRS	1.1E-02		
CE-141	3.25E+01 DYS	8.9E-05		
CE-143+D	1.37E+00 DYS	3.0E-05	PR-143	41.
CE-144+D	2.85E+02 DYS	1.3E-05	PR-144	96.
PR-143	1.37E+01 DYS	4.0E-06		
PR-144	1.73E+01 MIN	4.6E+06		
ND-147	1.11E+01 DYS	3.8E-05		
PM-147	2.60E+00 YRS	9.9E-04		
W--187	2.40E+01 HRS	5.1E-05		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	1.6E-03		
AC-227	2.16E+01 YRS	5.1E-04		
TH-227+D	1.82E+01 DYS	1.0E+07	RA-223	12.
PA-231D	3.25E+04 YRS	1.6E+01	AC-227	100.
U--235	7.10E+08 YRS	1.0E+07		
NP-239D	2.35E+00 DYS	2.3E+06	PU-239	100.
PU-239	2.44E+04 YRS	3.0E-01		

BASED ON: EXTERNAL EXPOSURE TO BURIED WASTE
A MAXIMUM DOSE COMMITMENT OF 1.00 MR/YP
EXPOSURE TIME = 1.0E+02 HOURS
DECAY TIME FROM BURIAL TO EXPOSURE = 1.0E-03 YEARS
WASTE DENSITY = 1.0 GM/CC
FRACTION OF SOIL WHICH IS WASTE = 1.0E+00

TABLE 48

CASE I-J -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H----3	1.23E+01 YRS	1.0E+07		
C---14	5.73E+03 YRS	1.8E-03		
NA--24	1.50E+01 HRS	4.6E-04		
P---32	1.43E+01 DYS	5.8E-05		
CR--51	2.78E+01 DYS	2.0E-04		
MN--54	3.12E+02 DYS	8.8E-06		
MN--56	2.58E+01 HRS	1.7E+06		
FE--55	2.43E+00 YRS	1.3E+07		
FE--59	4.50E+01 DYS	6.9E-06		
CO--58	7.13E+01 DYS	7.4E-06		
CO--60	5.24E+01 YRS	3.2E-06		
NI--59	9.01E+04 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.3E+07		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.7E-02		
ZN--65	2.43E+02 DYS	1.3E-05		
ZN--69	5.50E+01 MIN	1.0E+07		
BR--83+D	2.40E+01 HRS	1.0E+07	KR-83M	10.
BR--84	3.20E+01 MIN	1.3E+07		
BR--85C	3.00E+00 MIN	2.1E+02	KR--85	100.
RB--86	1.87E+01 DYS	2.9E-05		
FR--88	1.80E+01 MIN	1.0E+07		
RB--89D	1.50E+01 MIN	2.1E-01	SR--89	100.
SR--89	5.06E+01 DYS	4.2E-05		
SR--90+D	2.88E+01 YRS	2.4E-05	Y---90	87.
SR--91+D	9.70E+00 HRS	5.4E-03	Y---91	71.
SF--92D	2.70E+00 HRS	1.6E+03	Y---92	100.
Y---90	2.67E+00 DYS	8.9E-05		
Y--91MC	5.00E+01 MIN	9.0E-02	Y---91	100.
Y---91	5.90E+01 DYS	5.2E-05		
Y---92	3.53E+00 HRS	5.0E+03		
Y---93	1.02E+01 HRS	3.1E-02		
ZR--93+D	1.50E+06 YRS	2.3E-02	NB-93M	30.
7P--95+D	6.50E+01 DYS	8.4E-06	NB--95	10.
7R--97+D	1.70E+01 HRS	5.0E-04	NB--97	47.
NB-93M	3.70E+00 YRS	1.3E-04		
NB--95	3.50E+01 DYS	9.7E-06		
NB--97	1.20E+00 HRS	1.0E+07		
MO--99+D	2.79E+00 DYS	7.9E-05	TC-99M	27.
TC-99M	6.00E+00 HRS	2.0E+01		
TC--99	2.10E+05 YRS	5.7E-04		
RU-103	4.00E+01 DYS	1.3E-05		
RU-105D	4.43E+00 HRS	4.5E-03	RH-105	100.
RU-106D	1.00E+00 YRS	9.3E-06	RH-106	100.
RH-105	1.50E+00 DYS	6.4E-04		
AG110M	2.60E+02 DYS	2.7E-06		
TE125M	5.90E+01 DYS	2.0E-03		
TE127MD	1.05E+02 DYS	1.3E-04	TE-127	100.
TE-127	9.30E+00 HRS	6.2E-01		
TE129M+D	3.40E+01 DYS	2.5E-05	TE-129	83.

TABLE 48

CASE I-J -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO WORKERS AFTER 0.01 YR

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129C	1.12E+01 HRS	1.1E+07	I--129	100.
TE-131M+D	1.20E+00 DYS	6.6E-05	I--131	42.
TE-131C	2.50E+01 MIN	1.2E-02	I--131	100.
TE-132+D	3.25E+00 DYS	7.7E-06	I--132	92.
I--129	1.60E+07 YRS	1.1E-03		
I--130	1.24E+01 HRS	2.1E-03		
I--131	8.15E+00 DYS	2.5E-05		
I--132	2.33E+00 HRS	1.0E+07		
I--133+D	2.10E+01 HRS	4.8E-04	XE-133	22.
I--134	5.30E+01 MIN	1.0E+07		
I--135+D	6.70E+00 HRS	4.1E-02	XE-135	87.
CS-134	2.10E+00 YRS	3.8E-06		
CS-135	2.10E+06 YRS	1.2E-03		
CS-136	1.30E+01 DYS	4.5E-06		
CS-137+D	3.10E+01 YRS	9.1E-06	3A137M	95.
CS-138	3.22E+01 MIN	1.0E+07		
PA-140+D	1.28E+01 DYS	3.8E-06	LA-140	86.
PA-141C	1.80E+01 MIN	2.5E-01	CE-141	100.
PA-142C	1.10E+01 MIN	1.0E+07	LA-142	100.
LA-140	1.67E+00 DYS	3.1E-05		
LA-141C	3.90E+00 HRS	1.9E-02	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	9.6E-05		
CE-143+D	1.37E+00 DYS	4.7E-05	PR-143	82.
CE-144+D	2.85E+02 DYS	1.3E-05	PR-144	96.
PR-143	1.37E+01 DYS	5.8E-06		
PR-144	1.73E+01 MIN	1.0E+07		
ND-147	1.11E+01 DYS	4.6E-05		
PM-147	2.60E+00 YRS	9.9E-04		
W--147	2.40E+01 HRS	5.0E-04		
RA-223	1.14E+01 DYS	1.0E+07		
RA-226	1.60E+03 YRS	1.6E-03		
AC-227	2.16E+01 YRS	5.1E-04		
TH-227+D	1.82E+01 DYS	1.0E+07	RA-223	24.
PA-231D	3.25E+04 YRS	1.6E+00	AC-227	100.
U--235	7.10E+08 YRS	1.0E+07		
NP-239C	2.35E+00 DYS	1.4E+06	PU-239	100.
PU-239	2.44E+04 YRS	3.0E-01		

BASED ON: EXTERNAL EXPOSURE TO BURIED WASTE
A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR
EXPOSURE TIME = 1.0E+02 HOURS
DECAY TIME FROM BURIAL TO EXPOSURE = 1.0E+02 YEARS
WASTE DENSITY = 1.0 GM/CC
FRACTION OF SOIL WHICH IS WASTE = 1.0E+00

TABLE 52

CASE I-K -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.0E+07		
C---14	5.73E+03 YRS	2.6E+04		
NA--24	1.50E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.0E+07		
CF--51	2.78E+01 DYS	1.0E+07		
MN--54	3.12E+02 DYS	9.7E+05		
MN--56	2.59E+03 HRS	1.0E+07		
FE--55	2.4E+01 YRS	1.0E+07		
FE--59	4.5E+01 DYS	6.6E+06		
CO--58	7.10E+01 DYS	1.7E+02		
CO--60	5.24E+00 YRS	9.3E+07		
NI--59	9.1E+01 YRS	1.0E+07		
NI--63	9.21E+01 YRS	1.0E+07		
NI--65	2.56E+01 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	4.7E+04		
ZN--66	5.50E+01 MIN	1.0E+07		
BF--83	2.4E+01 HRS	1.0E+07		
PR--84	3.2E+01 MIN	1.0E+07		
RE--85	3.0E+01 MIN	4.2E+01	KE--85	100.
RB--86	1.97E+01 DYS	1.0E+07		
RA--88	1.8E+01 MIN	1.0E+07		
RP--89	1.50E+01 MIN	1.0E+07	SP--89	100.
SR--89	5.6E+01 DYS	1.6E+06		
SR--90+D	2.8E+01 YRS	3.1E+06	Y---90	90.
SR--91D	9.7E+01 HRS	7.4E+06	Y---91	100.
SE--92	2.7E+00 HRS	1.0E+07		
Y---9.	2.67E+01 DYS	1.0E+07		
Y--91MD	5.0E+01 MIN	1.0E+07	Y---91	100.
Y---91	5.9E+01 DYS	5.1E+04		
Y---92	3.53E+01 HRS	1.0E+07		
Y---93D	1.02E+01 HRS	4.1E+04	NR-93M	99.
ZR--93+D	1.5E+06 YRS	3.2E+05	NR-93M	99.
ZR--95+D	6.5E+01 DYS	3.6E+02	NB--95	69.
ZP--97	1.7E+01 HRS	1.0E+07		
NB-93M	3.7E+01 YRS	5.3E+05		
NR--95	3.5E+01 DYS	1.0E+07		
NB--97	1.2E+00 HRS	1.0E+07		
MO--99D	2.79E+00 DYS	2.2E+03	TC--99	100.
TC-99MD	6.0E+00 HRS	2.5E+04	TC--99	100.
TC--99	2.1E+05 YRS	8.1E+05		
RU-103	4.1E+01 DYS	1.0E+07		
SU-105	4.43E+00 HRS	1.0E+07		
SU-106C	1.0E+00 YRS	5.3E+05	RH-106	100.
FM-105	1.50E+00 DYS	1.0E+07		
AG110M	2.6E+02 DYS	7.2E+05		
TE125M	5.8E+01 DYS	2.9E+06		
TE127MD	1.05E+02 DYS	6.7E+00	TE-127	100.
TE-127	9.3E+01 HRS	1.0E+07		
TE129MD	3.4E+01 DYS	2.6E+04	I--129	100.

TABLE 52
CASE I-K -- SANITARY LANDFILL -
GROUND SURFACE EXPOSURE TO RESIDENTS AFTER 5 YRS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+00 HRS	1.0E+07	I--129	100.
TE-131D	1.20E+00 DYS	1.0E+07	XE131M	100.
TE-131C	2.50E+01 MIN	1.0E+07	XE131M	100.
TE-132D	3.25E+00 DYS	1.0E+07	I--132	92.
I--129	1.60E+07 YRS	1.5E-04		
I--131	1.24E+01 HRS	1.0E+07		
I--131D	4.05E+00 DYS	1.0E+07	XE131M	100.
I--132	2.30E+00 HRS	1.0E+07		
I--133D	2.10E+01 HRS	1.0E+07	XE-133	100.
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	4.5E+05	CS-135	100.
CS-134	2.10E+00 YRS	3.2E-06		
CS-135	2.00E+06 YRS	1.7E-04		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137D	3.00E+01 YRS	1.5E-06	BA137M	95.
CS-138	3.22E+01 MIN	1.0E+07		
BA-140D	1.28E+01 DYS	1.0E+07	LA-140	88.
BA-141D	1.80E+01 MIN	1.0E+07	CE-141	100.
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-141D	3.90E+00 HRS	1.0E+07	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143D	1.37E+01 DYS	1.0E+07	PR-143	100.
CE-144D	2.85E+02 DYS	2.2E-04	PK-144	96.
PR-143	1.37E+01 DYS	1.0E+07		
PR-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	5.0E-02	PM-147	100.
PM-147	2.60E+00 YRS	5.9E-04		
W--187	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07		
FA-226	1.60E+03 YRS	2.3E-04		
AC-227	2.16E+01 YRS	8.7E-05		
TH-227D	1.82E+01 DYS	1.0E+07	RA-223	73.
PA-231D	3.25E+04 YRS	4.6E-04	AC-227	100.
U--235	7.10E+08 YRS	1.0E+07		
NP-239D	2.35E+00 DYS	1.6E+05	PU-239	100.
PU-239	2.44E+04 YRS	4.2E-02		

BASED ON: EXTERNAL EXPOSURE TO BURIED WASTE
A MAXIMUM DOSE COMMITMENT OF 1.0E MREM/YR
EXPOSURE TIME = 7.0E+03 HOURS
DECAY TIME FROM BURIAL TO EXPOSURE = 5.0E+00 YEARS
WASTE DENSITY = 1.0 GM/CC
FRACTION OF SOIL WHICH IS WASTE = 1.0E-01

TABLE 76

CASE II-K -- FILL WANTED --
GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.0E+07		
C---14	5.73E+03 YRS	4.5E-04		
NA--24	1.50E+01 HRS	4.0E-05		
P---32	1.43E+01 DYS	4.5E-05		
CR--51	2.78E+01 DYS	1.0E-04		
MN--54	3.12E+02 DYS	2.4E-06		
MN--56	2.58E+00 HRS	5.0E-04		
FE--55	2.40E+00 YRS	1.0E+07		
FE--59	4.50E+01 DYS	2.3E-06		
CO--56	7.10E+01 DYS	2.6E-06		
CO--60	5.24E+00 YRS	8.0E-07		
NI--59	9.01E+04 YRS	1.0E+07		
NI--63	9.21E+00 YRS	1.0E+07		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	7.5E-04		
Zn--65	2.43E+02 DYS	3.5E-06		
ZN--69	5.50E+01 MIN	3.1E-02		
AR--83+0	2.40E+00 HRS	1.2E-02	KF-834	2.
AR--84	3.20E+01 MIN	1.3E-03		
KA--95+0	3.00E+00 MIN	8.4E-02	KF-954	34.
PA--86	1.87E+01 DYS	1.9E-05		
PA--88	1.80E+01 MIN	5.6E-03		
KA--89+0	1.50E+01 MIN	3.0E-03	SA--89	5.
SA--89	5.06E+01 DYS	1.6E-05		
SR--90+0	2.88E+01 YRS	4.9E-06	Y---90	89.
SE--91+0	9.70E+00 HRS	1.7E-04	Y--91M	30.
SE--92+0	2.70E+00 HRS	4.1E-04	Y---92	36.
Y---90	2.67E+00 DYS	1.1E-04		
Y--91M+0	5.00E+01 MIN	3.6E-03	Y---91	11.
Y---91	5.90E+01 DYS	1.4E-05		
Y---92	3.53E+00 HRS	8.5E-04		
Y---93	1.02E+01 HRS	4.0E-04		
ZR--93+0	1.50E+06 YRS	1.4E-03	NR-934	83.
ZR--95+0	6.50E+01 DYS	2.1E-06	NR--95	36.
ZR--97+0	1.70E+01 HRS	7.1E-05	NB--97	45.
NB-934	3.70E+01 YRS	3.4E-05		
NB--95	3.50E+01 DYS	4.4E-06		
NB--97	1.20E+00 HRS	2.2E-03		
MO--99+0	2.79E+00 DYS	1.0E-04	TC-994	26.
TC-994	6.00E+00 HRS	4.1E-03		
TC--99	2.10E+05 YRS	1.4E-04		
FU-113	4.00E+01 DYS	5.6E-06		
FU-115+0	4.43E+00 HRS	5.4E-04	KH-105	13.
FU-1160	1.00E+00 YRS	2.4E-06	RH-106	1.0.
PH-115	1.50E+00 DYS	5.0E-04		
AG-116M	2.60E+02 DYS	7.5E-07		
TE-125M	5.80E+01 DYS	7.4E-04		
TE-127M0	1.05E+02 DYS	4.0E-05	TE-127	100.
TE-127	9.30E+00 HRS	4.5E-03		
TE-129M+0	3.40E+01 DYS	1.1E-05	TE-129	82.

TABLE 76

CASE II-K -- FILL WANTED -
GROUND SURFACE EXPOSURE TO RESIDENTS AFTER NO DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+00 HRS	8.3E-03		
TE-131M+D	1.23E+00 DYS	4.7E-05	I--131	25.
TE-131+D	2.5E+01 MIN	5.5E-03	I--131	42.
TE-132+D	3.25E+01 DYS	1.1E-05	I--132	92.
I--129	1.63E+07 YRS	2.7E-04		
I--130	1.24E+01 HRS	8.5E-05		
I--131	3.15E+00 DYS	2.8E-05		
I--132	2.30E+00 HRS	3.9E-04		
I--133+D	2.13E+01 HRS	1.1E-04	XE-133	5.
I--134	5.36E+01 MIN	1.3E-03		
I--135+D	6.70E+00 HRS	1.6E-04	XE-135	15.
CS-134	2.16E+00 YRS	9.9E-07		
CS-135	2.03E+06 YRS	3.1E-04		
CS-136	1.30E+01 DYS	3.4E-06		
CS-137+D	3.11E+01 YRS	2.7E-06	3A137M	95.
CS-138	3.22E+01 MIN	1.9E-03		
3A-140+D	1.23E+01 DYS	3.1E-06	LA-140	56.
RA-141+D	1.63E+01 MIN	6.5E-03	LA-141	30.
RA-142+D	1.10E+01 MIN	4.4E-03	LA-142	74.
LA-140	1.67E+00 DYS	2.7E-05		
LA-141+D	3.90E+00 HRS	1.4E-03	CE-141	15.
LA-142	1.40E+00 HRS	7.3E-04		
CE-141	3.25E+01 DYS	4.5E-05		
CE-143+D	1.37E+00 DYS	3.7E-05	PR-143	80.
CE-144+D	2.65E+02 DYS	3.6E-06	PF-144	96.
PR-143	1.37E+01 DYS	4.7E-06		
PF-144	1.73E+01 MIN	1.6E-02		
ND-147	1.11E+01 DYS	4.2E-05		
PH-147	2.63E+00 YRS	2.5E-04		
W--147	2.40E+01 HRS	1.9E-04		
RA-223	1.14E+01 DYS	1.3E+07		
FA-226	1.60E+03 YRS	4.0E-04		
AC-227	2.16E+01 YRS	1.3E-04		
TH-227+D	1.82E+01 DYS	1.0E+07	RA-223	48.
PA-231D	3.25E+04 YRS	3.5E-02	AC-227	100.
U--235	7.10E+08 YRS	1.0E+07		
NP-239D	2.35E+00 DYS	2.9E+05	PU-239	100.
PU-239	2.44E+04 YRS	7.4E-02		

BASED ON: EXTERNAL EXPOSURE TO BURIED WASTE
A MAXIMUM DOSE COMMITMENT OF 1.00 MREM/YR
EXPOSURE TIME = 2.4E+03 HOURS
DECAY TIME FROM BURIAL TO EXPOSURE = 0. YEARS
WASTE DENSITY = 1.0 GM/CC
FRACTION OF SOIL WHICH IS WASTE = 2.0E-01

TABLE 96

CASE III-C -- SANITARY LANDFILL -
 IMHALATION SPILLED WASTE AFTER NO DECAY

ISCTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.1E+16		
C---14	5.73E+03 YRS	6.6E+04		
NA--24	1.50E+01 HRS	8.9E+04		
P---32	1.43E+01 DYS	9.1E+02		
CR--51	2.78E+01 DYS	8.3E+04		
MN--54	3.12E+02 DYS	8.6E+02		
MN--56	2.58E+01 HRS	5.9E+04		
FE--55	2.40E+01 YRS	1.5E+03		
FE--59	4.50E+01 DYS	4.3E+01		
CO--58	7.10E+01 DYS	1.3E+03		
CO--60	5.24E+01 YRS	2.0E+02		
NI--59	8.01E+04 YRS	1.8E+04		
NI--63	9.21E+01 YRS	2.8E+03		
NI--65	2.56E+01 HRS	9.7E+04		
CU--64	1.29E+01 HRS	2.5E+04		
ZN--66	2.43E+02 DYS	1.4E+03		
ZN--69	5.50E+01 MIN	1.3E+06		
BR--63	2.40E+01 HRS	5.1E+06		
BR--64	3.20E+01 MIN	3.8E+06		
BR--65	3.00E+01 MIN	1.0E+07		
RB--86	1.87E+01 DYS	8.9E+03		
RB--88	1.80E+01 MIN	3.1E+06		
RB--89	1.50E+01 MIN	4.7E+06		
SP--89	5.16E+01 DYS	8.6E+02		
SR--90	2.88E+01 YRS	1.2E+01		
SR--91	9.71E+00 HRS	5.9E+03		
SD--92	2.71E+00 HRS	2.9E+04		
Y---90	2.67E+01 DYS	2.4E+03		
Y--91M	5.00E+01 MIN	6.2E+05		
Y---91	5.90E+01 DYS	7.0E+02		
Y---92	3.53E+00 HRS	1.6E+04		
Y---93	1.02E+01 HRS	2.8E+03		
7R--93	1.50E+06 YRS	2.9E+03		
7R--95	6.51E+01 DYS	6.9E+02		
ZR--97	1.70E+01 HRS	2.3E+03		
NB-93M	3.70E+00 YRS	4.8E+03		
NB--95	3.50E+01 DYS	2.4E+03		
NB--97	1.20E+00 HRS	5.0E+05		
MO--99	2.79E+01 DYS	4.8E+03		
TC-99M	6.00E+01 HRS	2.9E+05		
TC--99	2.10E+05 YRS	1.1E+03		
RU-103	4.00E+01 DYS	2.4E+03		
RU-105	4.43E+00 HRS	2.5E+04		
RU-106	1.00E+01 YRS	1.3E+02		
RH-105	1.50E+00 DYS	1.4E+04		
AG110M	2.60E+02 DYS	2.6E+02		
TE125M	5.80E+01 DYS	3.8E+03		
TE127M	1.05E+02 DYS	1.3E+03		
TE-127	9.30E+00 HRS	2.1E+04		
TE129M	3.40E+01 DYS	1.1E+03		

TABLE 96

CASE III-C -- SANITARY LANDFILL -
INHALATION SPILLED WASTE AFTER NO DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129	1.12E+00 HRS	6.2E+05		
TE-131M	1.20E+00 DYS	2.2E+03		
TE-131	2.50E+01 MIN	8.6E+05		
TE-132	3.25E+00 DYS	2.4E+03		
I--129	1.60E+07 YRS	2.7E+01		
I--131	1.24E+01 HRS	6.9E+02		
I--131	8.15E+00 DYS	1.0E+02		
I--132	2.30E+01 HRS	2.7E+03		
I--133	2.10E+01 HRS	4.1E+02		
I--134	5.30E+01 MIN	5.2E+03		
I--135	6.70E+00 HRS	1.0E+03		
CS-134	2.10E+00 YRS	1.4E+03		
CS-135	2.00E+06 YRS	1.0E+04		
CS-136	1.30E+01 DYS	8.0E+03		
CS-137	3.00E+01 YRS	1.9E+03		
CS-138	3.02E+01 MIN	1.0E+06		
RA-141	1.25E+01 DYS	9.4E+02		
RA-141	1.80E+01 MIN	6.2E+05		
RA-142	1.10E+01 MIN	1.0E+06		
LA-141	1.67E+01 DYS	2.6E+03		
LA-141	3.90E+00 HRS	2.1E+04		
LA-142	1.40E+01 HRS	1.0E+05		
CE-142	3.25E+01 DYS	3.3E+03		
CE-143	1.37E+00 DYS	5.3E+03		
CE-144	2.85E+02 DYS	1.5E+02		
PR-142	1.37E+01 DYS	4.3E+03		
PR-144	1.73E+01 MIN	1.2E+06		
ND-147	1.11E+01 DYS	5.4E+03		
PM-147	2.60E+00 YRS	1.8E+03		
W--187	2.40E+01 HRS	7.7E+03		
KA-223	1.24E+01 DYS	5.9E+01		
KA-226	1.60E+03 YRS	1.2E+00		
AC-227	2.16E+01 YRS	6.5E+02		
TH-227	1.82E+01 DYS	4.0E+00		
PA-231	3.25E+04 YRS	3.0E+02		
U--235	7.10E+08 YRS	3.1E+00		
NF-239	2.35E+00 DYS	1.0E+04		
PU-239	2.44E+04 YRS	4.9E+02		

BASED ON: INHALATION OF WASTE SPILLED DURING DISPOSAL
 A MAXIMUM DOSE COMMITMENT OF 3.00 MREM/YR TO ADULTS
 WASTE CONCENTRATION IN AIR = 2.0E-02 MICROGRAMS PER CUBIC METER
 EXPOSURE TIME = 1.0E+03 HOURS/YEAR
 BREATHING RATE = 1.0 CUBIC METERS PER HOUR
 DECAY TIME FROM SPILLAGE TO EXPOSURE = 0.
 FRACTION OF MATERIAL INHALED WHICH IS WASTE = 1.000

TABLE 104

CASE III-D -- SANITARY LANDFILL -
INHALATION DURING SITE EXCAVATION AFTER 5 YRS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H----3	1.23E+01 YRS	1.5E+03		
C---14	5.73E+03 YRS	6.6E+01		
NA--24	1.50E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.0E+07		
CP--51	2.78E+01 DYS	1.0E+07		
MK--54	3.12E+02 DYS	4.9E+01		
MN--56	2.58E+00 HRS	1.0E+07		
FE--55	2.40E+00 YRS	6.4E+01		
FE--59	4.50E+01 DYS	1.0E+07		
CO--58	7.10E+01 DYS	1.0E+07		
CO--60	5.24E+00 YRS	3.9E+01		
NI--59	8.1E+04 YRS	1.0E+01		
NI--63	9.21E+01 YRS	2.9E+01		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	2.5E+02		
ZN--69	5.50E+01 MIN	1.0E+07		
BR--83	2.40E+00 HRS	1.0E+07		
BR--84	3.20E+01 MIN	1.0E+07		
BR--85	3.00E+00 MIN	1.0E+07		
RB--86	1.87E+01 DYS	1.0E+07		
RB--88	1.80E+01 MIN	1.0E+07		
SR--89C	1.50E+01 MIN	1.0E+07	SR--89	100.
SR--89	5.0E+01 DYS	1.0E+07		
SR--90	2.83E+01 YRS	1.4E+02		
SR--91C	9.70E+00 HRS	1.0E+07	Y---91	100.
SR--92	2.70E+00 HRS	1.0E+07		
Y---90	2.67E+00 DYS	1.0E+07		
Y---91MC	5.0E+01 MIN	1.0E+07	Y---91	100.
Y---91	5.90E+01 DYS	1.0E+07		
Y---92	3.53E+01 HRS	1.0E+07		
Y---93C	1.02E+01 HRS	1.0E+07	ZR--93	74.
ZR--93+D	1.50E+06 YRS	2.1E+00	NB--93M	25.
ZR--95+D	6.50E+01 DYS	1.0E+07	NB--95	38.
ZR--97	1.70E+01 HRS	1.0E+07		
NB--93M	3.70E+00 YRS	1.2E+01		
NB--95	3.50E+01 DYS	1.0E+07		
NB--97	1.20E+00 HRS	1.0E+07		
MO--99C	2.79E+00 DYS	1.0E+07	TC--99	100.
TC--99MC	6.0E+00 HRS	1.0E+07	TC--99	100.
TC--99	2.10E+05 YRS	1.1E+00		
RU--103	4.00E+01 DYS	1.0E+07		
PU--105	4.43E+01 HRS	1.0E+07		
RU--106	1.00E+00 YRS	4.1E+01		
RH--105	1.50E+00 DYS	1.0E+07		
AG110M	2.60E+02 DYS	3.4E+01		
TE125M	5.80E+01 DYS	1.0E+07		
TE127M+D	1.05E+02 DYS	2.0E+05	Te-127	6.
TE-127	9.30E+01 HRS	1.0E+07		
TE129MC	3.40E+01 DYS	4.6E+06	I--129	100.

TABLE 104

CASE III-D -- SANITARY LANDFILL -
 INHALATION DURING SITE EXCAVATION AFTER 5 YRS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-1290	1.12E+00 HRS	1.0E+07	I--129	100.
TE-1310	1.20E+00 DYS	1.0E+07	I--131	100.
TE-1310	2.50E+01 MIN	1.0E+07	I--131	100.
TE-132+0	3.25E+00 DYS	1.0E+07	I--132	47.
I--129	1.60E+07 YRS	2.7E-02		
I--130	1.24E+01 HRS	1.0E+07		
I--131	8.15E+00 DYS	1.0E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--1350	6.70E+00 HRS	1.0E+07	CS-135	100.
CS-134	2.10E+00 YRS	7.4E+00		
CS-135	2.10E+06 YRS	1.0E+01		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137	3.10E+01 YRS	2.2E+00		
CS-136	3.22E+01 MIN	1.0E+07		
BA-140+0	1.28E+01 DYS	1.0E+07	LA-140	29.
BA-1410	1.80E+01 MIN	1.0E+07	CE-141	100.
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-1410	3.90E+00 HRS	1.0E+07	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-1430	1.37E+00 DYS	1.0E+07	PE-143	100.
CE-144	2.85E+02 DYS	1.3E+01		
PR-143	1.37E+01 DYS	1.0E+07		
PP-144	1.73E+01 MIN	1.0E+07		
ND-1470	1.11E+01 DYS	5.7E+02	PM-147	100.
PM-147	2.60E+00 YRS	6.8E+00		
W--187	2.40E+01 HRS	1.0E+07		
FA-223	1.14E+01 DYS	1.0E+07		
FA-226	1.60E+03 YRS	1.2E-03		
AC-227+0	2.16E+01 YRS	7.5E-05	TH-227	2.
TH-227+0	1.82E+01 DYS	1.0E+07	RA-223	64.
PA-231+0	3.25E+04 YRS	2.8E-05	AC-227	6.
U--235	7.10E+08 YRS	3.1E-03		
NP-2390	2.35E+00 DYS	1.9E+02	PU-239	100.
PU-239	2.44E+04 YRS	4.9E-05		

BASED ON: INHALATION OF AIRBORNE WASTE BY INTRUDER
 A MAXIMUM DOSE COMMITMENT OF 3.00 MREM/YR TO ADULTS
 WASTE CONCENTRATION IN AIR = 1.0 MG PER CUBIC METER
 EXPOSURE TIME = 1.0E+02 HOURS
 BREATHING RATE = 1.0 CUBIC METERS PER HOUR
 DECAY TIME FROM BURIAL TO EXPOSURE = 5.0E+00 YEARS
 FRACTION OF MATERIAL INHALED WHICH IS WASTE = .200

TABLE 112

CASE III-F -- SANITARY LANDFILL -
FOOD GROWN ON WASTE SITE AFTER 5 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H-3	1.23E+01 YRS	2.1E-04		
C-14	5.73E+03 YRS	5.4E-06		
NA-24	1.5E+01 HRS	1.1E+07		
P-32	1.43E+01 DYS	1.1E+07		
CR-51	2.78E+01 DYS	1.1E+07		
MN-54	3.12E+02 DYS	2.1E-02		
MN-56	2.58E+01 HRS	1.1E+07		
FE-55	2.43E+00 YRS	3.1E-02		
FE-59	4.52E+01 DYS	1.1E+07		
CO-58	7.10E+01 DYS	6.7E+04		
CO-60	5.24E+03 YRS	8.9E-04		
NI-59	8.01E+04 YRS	6.3E-04		
NI-63	9.21E+01 YRS	4.1E-05		
NI-65	2.56E+00 HRS	1.1E+07		
CU-64	1.29E+01 HRS	1.1E+07		
ZN-65	2.43E+02 DYS	1.2E-03		
ZN-69	5.50E+01 MIN	1.1E+07		
RP-83	2.40E+00 HRS	1.1E+07		
RP-84	3.2E+01 MIN	1.1E+07		
RP-85	3.03E+00 MIN	1.1E+07		
RB-86	1.87E+01 DYS	1.1E+07		
RB-88	1.80E+01 MIN	1.1E+07		
RB-89D	1.50E+01 MIN	1.1E+07	SR-99	100.
SR-89	5.16E+01 DYS	2.5E+06		
SR-90	2.88E+01 YRS	1.6E-06		
SR-91D	9.7E+00 HRS	1.1E+07	Y-91	100.
SR-92	2.7E+00 HRS	1.1E+07		
Y-90	2.67E+00 DYS	1.1E+07		
Y-91MD	5.1E+01 MIN	1.1E+07	Y-91	100.
Y-91	5.9E+01 DYS	2.1E+06		
Y-92	3.53E+00 HRS	1.1E+07		
Y-93D	1.02E+01 HRS	5.4E+06	NB-93M	99.
ZR-93+D	1.5E+06 YRS	4.2E-03	NB-93M	99.
ZR-95+D	6.5E+01 DYS	5.3E+04	NB-95	99.
7R-97	1.7E+01 HRS	1.1E+07		
NB-93M	3.7E+00 YRS	6.2E-03		
NB-95	3.5E+01 DYS	1.1E+07		
NB-97	1.2E+00 HRS	1.1E+07		
40-99D	2.79E+00 DYS	7.2E+02	TC-99	100.
TC-99MD	6.0E+00 HRS	8.0E+03	TC-99	100.
TC-99	2.1E+05 YRS	2.5E-05		
RU-103	4.1E+01 DYS	1.1E+07		
RU-105	4.43E+00 HRS	1.1E+07		
RU-106	1.1E+00 YRS	2.9E-04		
RH-115	1.5E+00 DYS	1.1E+07		
AG110M	2.6E+02 DYS	4.6E-04		
TE125M	5.9E+01 DYS	3.0E+04		
TE127M+D	1.05E+02 DYS	5.3E-01	TE-127	24.
TE-127	9.3E+00 HRS	1.1E+07		
TE129MC	3.40E+01 DYS	1.5E+02	I-129	100.

TABLE 112

CASE III-F -- SANITARY LANDFILL -
FOOD GROWN ON WASTE SITE AFTER 5 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-1290	1.12E+00 HRS	1.1E+05	I--129	100.
TS-131MD	1.23E+01 DYS	1.3E+07	I--131	100.
TE-131D	2.53E+01 MIN	1.3E+07	I--131	100.
TE-132+D	3.25E+00 DYS	1.3E+07	I--132	2.
I--129	1.63E+07 YRS	8.5E-07		
I--130	1.24E+01 HRS	1.3E+07		
I--131	4.05E+00 DYS	1.3E+07		
I--132	2.33E+00 HRS	1.3E+07		
I--133	2.10E+01 HRS	1.3E+07		
I--134	5.30E+01 MIN	1.3E+07		
I--135D	6.73E+00 HRS	1.2E+06	CS-135	100.
CS-134	2.13E+00 YRS	3.1E-04		
CS-135	2.03E+06 YRS	4.5E-04		
CS-136	1.33E+01 DYS	1.3E+07		
CS-137	3.03E+01 YRS	9.1E-05		
CS-138	3.22E+01 MIN	1.3E+07		
BA-140+D	1.28E+01 DYS	1.3E+07	LA-140	55.
BA-141D	1.93E+01 MIN	1.3E+07	CE-141	100.
BA-142	1.13E+01 MIN	1.3E+07		
LA-140	1.67E+00 DYS	1.3E+07		
LA-141D	3.90E+00 HRS	1.3E+07	CE-141	100.
LA-142	1.43E+00 HRS	1.3E+07		
CE-141	3.25E+01 DYS	1.3E+07		
CE-143D	1.37E+00 DYS	1.3E+07	PE-143	100.
CE-144	2.85E+02 DYS	3.8E-02		
PE-143	1.37E+01 DYS	1.3E+07		
PM-144	1.73E+01 MIN	1.3E+07		
ND-147D	1.11E+01 DYS	2.8E+00	PM-147	100.
PM-147	2.63E+00 YRS	3.3E-02		
W--187	2.43E+01 HRS	1.0E+07		
PA-223	1.14E+01 DYS	1.3E+07		
PA-226	1.60E+03 YRS	1.1E-06		
AC-227+D	2.16E+01 YRS	2.1E-05	RA-223	27.
TH-227+D	1.82E+01 DYS	1.3E+07	RA-223	78.
PA-231+D	3.25E+04 YRS	1.3E-05	AC-227	6.
U--235	7.10E+08 YRS	9.5E-05		
NP-239D	2.35E+00 DYS	4.3E+03	PU-239	100.
FU-239	2.44E+04 YRS	1.1E-03		

BASED ON CONSUMPTION OF FOOD GROWN ON WASTE SITE
 A MAXIMUM DOSE COMMITMENT OF 3.00 MREM/YR TO ADULTS
 DECAY TIME FROM BURIAL TO INGESTION = 5.3E+01 YEARS
 CONSUMPTION OF 150. KG OF FRUITS AND VEGETABLES PER YEAR
 CONSUMPTION OF 310. LITERS OF MILK PER YEAR
 CONSUMPTION OF 11. KG OF MEAT PER YEAR
 CONSUMPTION RATE OF COW = 50. KG/DAY
 CONSUMPTION RATE OF CATTLE = 50. KG/DAY
 FRACTION OF SOIL WHICH IS WASTE = .11

TABLE 114

CASE III-F -- SANITARY LANDFILL -
FOOD GROWN ON WASTE SITE AFTER 100 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/G4)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	4.3E-02		
C---14	5.73E+03 YRS	5.5E-06		
NA--24	1.50E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.0E+07		
CF--51	2.78E+01 DYS	1.0E+07		
MN--54	3.12E+02 DYS	1.0E+07		
MN--56	2.58E+01 HRS	1.0E+07		
FE--55	2.46E+01 YRS	1.0E+07		
FE--59	4.50E+01 DYS	1.0E+07		
CO--58	7.10E+01 DYS	1.0E+07		
CO--60	5.24E+00 YRS	2.5E-02		
NI--59	8.01E+04 YRS	6.3E-04		
NI--63	9.21E+01 YRS	1.0E-04		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--66	2.43E+02 DYS	1.0E+07		
ZN--69	5.50E+01 MIN	1.0E+07		
BR--83	2.40E+00 HRS	1.0E+07		
BR--84	3.20E+01 MIN	1.0E+07		
BR--85	3.00E+00 MIN	1.0E+07		
PS--86	1.87E+01 DYS	1.0E+07		
RB--88	1.81E+01 MIN	1.0E+07		
BR--89	1.50E+01 MIN	1.0E+07	SP--89	100.
SA--89	5.06E+01 DYS	1.0E+07		
SR--90	2.89E+01 YRS	1.6E-05		
SR--91	9.70E+00 HRS	1.0E+07	Y---91	100.
SF--92	2.70E+00 HRS	1.0E+07		
Y---92	2.67E+00 DYS	1.0E+07		
Y--92MD	5.00E+01 MIN	1.0E+07	Y---91	100.
Y---92	5.91E+01 DYS	1.0E+07		
Y---92	3.53E+00 HRS	1.0E+07		
Y---93	1.02E+01 HRS	3.3E+06	NB-934	99.
7R--93+0	1.50E+00 YRS	2.5E-03	NB-934	99.
7F--95+0	6.50E+01 DYS	1.0E+07	NB--95	99.
ZR--97	1.70E+01 HRS	1.0E+07		
NR-93+	3.71E+00 YRS	3.3E+05		
NR--95	3.50E+01 DYS	1.0E+07		
NR--97	1.20E+01 HRS	1.0E+07		
MO--99	2.79E+00 DYS	7.2E+02	TC--99	100.
TC-99MD	6.00E+00 HRS	8.0E+03	TC--99	100.
TC--99	2.11E+05 YRS	2.6E-05		
RU-103	4.01E+01 DYS	1.0E+07		
RU-105	4.43E+00 HRS	1.0E+07		
RU-106	1.00E+00 YRS	1.0E+07		
RH-105	1.50E+00 DYS	1.0E+07		
AG-106	2.60E+02 DYS	1.0E+07		
TE125P	5.80E+01 DYS	1.0E+07		
TE127M+D	1.05E+02 DYS	1.0E+07	TE-127	24.
TE-127	9.30E+00 HRS	1.0E+07		
TE129MD	3.40E+01 DYS	1.5E+02	I--129	100.

TABLE 114

CASE III-F -- SANITARY LANDFILL -
FOOD GROWN ON WASTE SITE AFTER 100 YEARS

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+03 HRS	1.1E+05	I--129	100.
TE-131M	1.20E+03 DYS	1.0E+07		
TE-131	2.50E+01 MIN	1.0E+07		
TE-132	3.25E+00 DYS	1.0E+07		
I--129	1.60E+07 YRS	8.5E-07		
I--130	1.24E+01 HRS	1.0E+07		
I--131	3.75E+01 DYS	1.0E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	1.2E+06	CS-135	100.
CS-134	2.10E+03 YRS	1.0E+07		
CS-135	2.10E+06 YRS	4.5E-04		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137	3.00E+01 YRS	8.2E-04		
CS-138	3.22E+01 MIN	1.0E+07		
BA-141	1.20E+01 DYS	1.0E+07		
BA-141	1.00E+01 MIN	1.0E+07		
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-141	3.90E+00 HRS	1.0E+07		
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143	1.37E+00 DYS	1.0E+07		
CE-144	2.85E+02 DYS	1.0E+07		
PR-143	1.37E+01 DYS	1.0E+07		
PP-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	1.0E+07	PM-147	100.
PM-147	2.60E+00 YRS	1.0E+07		
W--187	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07		
FA-226	1.60E+03 YRS	1.1E-06		
AC-227+D	2.16E+01 YRS	4.5E-04	RA-223	27.
TH-227	1.92E+01 DYS	1.0E+07		
PA-231+D	3.25E+04 YRS	8.4E-06	AC-227	23.
U--235	7.10E+08 YRS	9.5E-05		
NP-239D	2.35E+01 DYS	4.0E+03	PU-239	100.
PU-239	2.44E+04 YRS	1.1E-03		

BASED ON: CONSUMPTION OF FOOD GROWN ON WASTE SITE
 A MAXIMUM DOSE COMMITMENT OF 3.00 MREM/YR TO ADULTS
 DECAY TIME FROM BURIAL TO INGESTION = 1.0E+02 YEARS
 CONSUMPTION OF 150. KG OF FRUITS AND VEGETABLES PER YEAR
 CONSUMPTION OF 310. LITERS OF MILK PER YEAR
 CONSUMPTION OF 11. KG OF MEAT PER YEAR
 CONSUMPTION RATE OF COW = 50. KG/DAY
 CONSUMPTION RATE OF CATTLE = 50. KG/DAY
 FFACTION OF SOIL WHICH IS WASTE = .10

TABLE 129

CASE IV-F -- FILL WANTED DISPOSAL -
FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY

ISCTOFE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	1.0E-04		
C---14	5.73E+03 YRS	3.7E-06		
NA--24	1.50E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.3E-03		
CR--51	2.78E+01 DYS	5.0E+01		
MN--54	3.12E+02 DYS	3.6E-04		
MN--56	2.58E+00 HRS	1.0E+07		
FE--55	2.40E+00 YRS	4.5E-03		
FE--59	4.50E+01 DYS	6.1E-02		
CO--58	7.10E+01 DYS	3.8E-03		
CO--61	5.24E+04 YRS	2.0E-04		
NI--59	9.01E+04 YRS	3.9E-04		
NI--63	9.21E+01 YRS	3.0E-05		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	8.7E-06		
ZN--69	5.50E+01 MIN	1.0E+07		
BR--83	2.40E+00 HRS	1.0E+07		
BR--84	3.20E+01 MIN	1.0E+07		
BR--85	3.00E+00 MIN	1.0E+07		
RB--86	1.87E+01 DYS	1.2E-02		
RB--88	1.80E+01 MIN	1.0E+07		
SR--89	1.50E+01 MIN	1.1E+00	SR--89	100.
SR--89	5.6E+01 DYS	2.2E-04		
SR--90	2.89E+01 YRS	7.5E-07		
SP--910	9.70E+00 HRS	6.1E-01	Y---91	100.
SR--92	2.70E+00 HRS	1.0E+07		
Y---90	2.67E+00 DYS	1.0E+07		
Y--910	5.00E+01 MIN	7.2E+00	Y---91	100.
Y---91	5.90E+01 DYS	4.2E-03		
Y---92	3.53E+00 HRS	1.0E+07		
Y---930	1.02E+01 HRS	1.0E+07	NB-93M	93.
ZR--93+0	1.50E+06 YRS	1.4E-02	NB-93M	93.
ZR--95+0	6.50E+01 DYS	9.3E-04	NB--95	99.
ZR--97+0	1.70E+01 HRS	1.0E+07	NE--97	5.
NR-93M	3.70E+00 YRS	1.4E-03		
NB--95	3.50E+01 DYS	8.7E-03		
NR--97	1.20E+00 HRS	1.0E+07		
MO--990	2.79E+00 DYS	4.8E+02	TC--99	100.
TC-990	6.00E+00 HRS	5.4E+03	TC--99	100.
TC--99	2.10E+05 YRS	1.3E-05		
RU-103	4.00E+01 DYS	8.9E-04		
RU-1050	4.43E+00 HRS	1.0E+07	RH-105	100.
RU-106	1.00E+00 YRS	6.4E-06		
RH-105	1.50E+00 DYS	1.0E+07		
AG110M	2.60E+02 DYS	4.9E-06		
TE125M	5.80E+01 DYS	4.7E-05		
TE127M+0	1.05E+02 DYS	5.3E-06	TE-127	24.
TE-127	9.30E+00 HRS	1.0E+07		
TE129M	3.40E+01 DYS	4.1E-05		

TABLE 129

CASE IV-F -- FILL WANTED DISPOSAL -
FOOD GROWN IN WASTE AFTER 0.5 YEARS DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129D	1.12E+00 HRS	6.6E+04	I--129	100.
TE-131MC	1.20E+00 DYS	7.4E+01	I--131	100.
TE-131D	2.50E+01 MIN	6.0E+03	I--131	100.
TE-132+D	3.25E+00 DYS	1.0E+07	I--132	1.
I--129	1.60E+07 YRS	5.2E-07		
I--131	1.24E+01 HRS	1.0E+07		
I--131	8.15E+00 DYS	1.3E+01		
I--132	2.30E+00 HRS	1.7E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	8.2E+05	CS-135	100.
CS-134	2.10E+00 YRS	4.9E-05		
CS-135	2.00E+06 YRS	3.1E-04		
CS-136	1.30E+01 DYS	4.0E+00		
CS-137	3.70E+01 YRS	5.7E-05		
CS-138	3.22E+01 MIN	1.0E+07		
BA-141+D	1.28E+01 DYS	4.1E+00	LA-140	55.
BA-141D	1.8E+01 MIN	2.0E+02	CE-141	100.
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-141D	3.90E+00 HRS	1.6E+01	CE-141	100.
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	7.3E-02		
CE-143D	1.37E+00 DYS	8.3E+01	PR-143	100.
CE-144	2.85E+02 DYS	3.1E-04		
PR-143	1.37E+01 DYS	1.0E+01		
PR-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	4.2E+01	PM-147	100.
PM-147	2.60E+00 YRS	5.0E-03		
W--187	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	2.7E+00		
RA-226	1.60E+03 YRS	6.3E-07		
AC-227+D	2.16E+01 YRS	9.8E-06	RA-223	23.
TH-227+D	1.82E+01 DYS	1.2E-02	RA-223	73.
PA-231	3.25E+04 YRS	7.4E-06		
U--235	7.10E+08 YRS	4.9E-05		
NP-239D	2.35E+00 DYS	2.0E+03	PU-239	100.
PU-239	2.44E+04 YRS	5.3E-04		

BASED ON: CONSUMPTION OF FOOD GROWN ON WASTE SITE
 A MAXIMUM DOSE COMMITMENT OF 3.00 REM/YR TO ADULTS
 DECAY TIME FROM BURIAL TO INGESTION = 5.0E-01 YEARS
 CONSUMPTION OF 150. KG OF FRUITS AND VEGETABLES PER YEAR
 CONSUMPTION OF 155. LITERS OF MILK PER YEAR
 CONSUMPTION OF 11. KG OF MEAT PER YEAR
 CONSUMPTION RATE OF COW = 50. KG/DAY
 CONSUMPTION RATE OF CATTLE = 50. KG/DAY
 FRACTION OF SOIL WHICH IS WASTE = .20

TABLE 132

CASE IV-F -- FILL WANTED DISPOSAL -
FOOD GROWN IN WASTE AFTER 100 YEARS DECAY

ISOTOPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
H---3	1.23E+01 YRS	2.8E-02		
C---14	5.73E+03 YRS	3.7E-06		
NA--24	1.50E+01 HRS	1.0E+07		
P---32	1.43E+01 DYS	1.0E+07		
CR--51	2.78E+01 DYS	1.0E+07		
MN--54	3.12E+02 YRS	1.0E+07		
MN--56	2.58E+00 HRS	1.0E+07		
FE--55	2.40E+00 YRS	1.0E+07		
FE--59	4.50E+01 DYS	1.0E+07		
CO--58	7.10E+01 DYS	1.0E+07		
CO--60	5.24E+00 YRS	1.3E+02		
NI--59	8.01E+04 YRS	3.9E-04		
NI--63	9.21E+01 YRS	6.3E-05		
NI--65	2.56E+00 HRS	1.0E+07		
CU--64	1.29E+01 HRS	1.0E+07		
ZN--65	2.43E+02 DYS	1.0E+07		
ZN--69	5.50E+01 MIN	1.0E+07		
BR--83	2.40E+00 HRS	1.0E+07		
BR--84	3.20E+01 MIN	1.0E+07		
BR--85	3.00E+00 MIN	1.0E+07		
BR--86	1.87E+01 DYS	1.0E+07		
BR--88	1.80E+01 MIN	1.0E+07		
BR--89M	1.50E+01 MIN	1.0E+07	SR--89	100.
SR--89	5.06E+01 DYS	1.0E+07		
SR--91	2.88E+01 YRS	8.2E-06		
SR--91D	9.70E+00 HRS	1.0E+07	Y---91	100.
SR--92	2.70E+00 HRS	1.0E+07		
Y---91	2.67E+00 DYS	1.0E+07		
Y---91MD	5.00E+01 MIN	1.0E+07	Y---91	100.
Y---91	5.90E+01 DYS	1.0E+07		
Y---92	3.53E+00 HRS	1.0E+07		
Y---93D	1.02E+01 HRS	1.7E+06	NB-93M	99.
ZR--93D	1.50E+06 YRS	1.3E-03	NB-93M	99.
ZP--95D	6.50E+01 DYS	1.0E+07	NB--95	99.
ZF--97	1.70E+01 HRS	1.0E+07		
NB-93M	3.70E+00 YRS	1.7E+05		
NB--95	3.50E+01 DYS	1.0E+07		
NB--97	1.20E+00 HRS	1.0E+07		
MO--99D	2.79E+00 DYS	4.3E+02	TC--99	100.
TC-99MD	6.00E+00 HRS	5.4E+03	TC--99	100.
TC--99	2.10E+05 YRS	1.8E-05		
RU-103	4.00E+01 DYS	1.0E+07		
RU-105	4.43E+00 HRS	1.0E+07		
RU-106	1.00E+01 YRS	1.0E+07		
RH-105	1.50E+00 DYS	1.0E+07		
AG111M	2.60E+02 DYS	1.0E+07		
TE125M	5.80E+01 DYS	1.0E+07		
TE127M+D	1.05E+02 DYS	1.0E+07	TE-127	24.
TE-127	9.30E+00 HRS	1.0E+07		
TE129MD	3.40E+01 DYS	9.0E+01	I--129	100.

TABLE 132

CASE IV-F -- FILL WANTED DISPOSAL -
FOOD GROWN IN WASTE AFTER 100 YEARS DECAY

ISCTCPE	HALF-LIFE	LIMITING BURIAL CONCEN. (UCI/GM)	DAUGHTER	PERCENT
TE-129C	1.12E+01 HRS	6.6E+04	I--129	100.
TE-131M	1.20E+00 DYS	1.0E+07		
TE-131	2.50E+01 MIN	1.0E+07		
TE-132	3.25E+00 DYS	1.0E+07		
I--129	1.60E+07 YRS	5.2E-07		
I--130	1.24E+01 HRS	1.0E+07	CS-135	100.
I--131	8.15E+00 DYS	1.0E+07		
I--132	2.30E+00 HRS	1.0E+07		
I--133	2.10E+01 HRS	1.0E+07		
I--134	5.30E+01 MIN	1.0E+07		
I--135D	6.70E+00 HRS	8.2E+05		
CS-134	2.10E+00 YRS	1.0E+07		
CS-135	2.00E+06 YRS	3.1E-04		
CS-136	1.30E+01 DYS	1.0E+07		
CS-137	3.00E+01 YRS	5.6E-04		
CS-138	3.22E+01 MIN	1.0E+07		
TA-140	1.20E+01 DYS	1.0E+07		
BA-141	1.80E+01 MIN	1.0E+07		
BA-142	1.10E+01 MIN	1.0E+07		
LA-140	1.67E+00 DYS	1.0E+07		
LA-141	3.90E+00 HRS	1.0E+07		
LA-142	1.40E+00 HRS	1.0E+07		
CE-141	3.25E+01 DYS	1.0E+07		
CE-143	1.37E+00 DYS	1.0E+07		
CE-144	2.85E+02 DYS	1.0E+07		
PF-143	1.37E+01 DYS	1.0E+07	PM-147	100.
PR-144	1.73E+01 MIN	1.0E+07		
ND-147D	1.11E+01 DYS	1.0E+07		
PM-147	2.60E+00 YRS	1.0E+07		
W--187	2.40E+01 HRS	1.0E+07		
RA-223	1.14E+01 DYS	1.0E+07	RA-223	23.
RA-226	1.60E+03 YRS	7.2E-07		
AC-227+D	2.16E+01 YRS	2.4E-04		
TH-227	1.82E+01 DYS	1.0E+07		
PA-231+D	3.25E+04 YRS	4.3E-06		
U--23F	7.10E+08 YRS	4.9E-05	PU-239	100.
NP-239D	2.35E+00 DYS	2.0E+03		
PU-239	2.44E+04 YRS	5.3E-04		

BASED ON: CONSUMPTION OF FOOD GROWN ON WASTE SITE
 A MAXIMUM DOSE COMMITMENT OF 3.00 MREM/YR TO ADULTS
 DECAY TIME FROM BURIAL TO INGESTION = 1.0E+02 YEARS
 CONSUMPTION OF 150. KG OF FRUITS AND VEGETABLES PER YEAR
 CONSUMPTION OF 155. LITERS OF MILK PER YEAR
 CONSUMPTION OF 11. KG OF MEAT PER YEAR
 CONSUMPTION RATE OF COW = 50. KG/DAY
 CONSUMPTION RATE OF CATTLE = 50. KG/DAY
 FRACTION OF SOIL WHICH IS WASTE = .20