REFERENCES

A. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I," U.S. Nuclear Regulatory Commission, Revision 1, October 1977.

B. Hamawi, J. N., "AEOLUS-2 - A Computer Code for the Determination of Continuous and Intermittent-Release Atmospheric Dispersion and Deposition of Nuclear Power Plant Effluents in Open-terrain Sites, Coastal Sites, and Deep-River Valleys for Assessment of Ensuing doses and Finite-Cloud Gamma Radiation Exposures," Entech Engineering, Inc., P100R13A, March 1988 (Mod 5, Revised by Yankee Atomic Electric Company, March 1992).

C. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," U.S. Nuclear Regulatory Commission, Rev. 1, July 1977.

D. National Bureau of Standards, "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," Handbook 69, June 5, 1959.

E. Slade, D. H., "Meteorology and Atomic Energy - 1968, USAEC, July 1968.

F. Lowder, W. M., P. D. Raft, and G. dePlanque Burke, "Determination of N-16 Gamma Radiation Fields at BWR Nuclear Power Stations," Health and Safety Laboratory, Energy Research and Development Administration, Report No. 305, May 1976.

G. Letter from Charles L. Miller of the United States Nuclear Regulatory Commission to John F. Schmidt of the Nuclear Energy Institute, dated December 26, 1995.

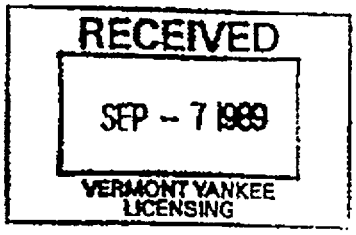
APPENDIX B

Approval of Criteria for Disposal of Slightly Contaminated Septic Waste On-Site at Vermont Yankee

Revision 9 Date 3/2/90

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

August 30, 1989



Docket No. 50-271

Mr. L. A. Tremblay
Licensing Engineering
Vermont Yankee Nuclear Power Corporation
Engineering Office
580 Main Street
Bolton, Massachusetts 01740-1398

Dear Mr. Tremblay:

SUBJECT: APPROVAL UNDER 10 CFR 20.302(a) OF PROCEDURES FOR DISPOSAL OF SLIGHTLY CONTAMINATED SEPTIC WASTE ON SITE AT VERMONT YANKEE (TAC NO. 73776)

REFERENCE: (a) June 28, 1989 letter from R. W. Capstick to US NRC Document Control Desk, including Attachment I and Attachment II.
(b) Final Environmental Statement related to the operation of Vermont Yankee Nuclear Power Station, dated July 1972.

In reference (a) Vermont Yankee Nuclear Power Corporation (Vermont Yankee, or the licensee) submitted an application for disposal of licensed material on site. This disposal was not previously considered by the staff in the Vermont Yankee Final Environmental Statement (FES), reference (b). This extensive application, prepared in accordance with 10 CFR 20.302(a), contains a detailed description of the licensed material, thoroughly analyzes and evaluates the information pertinent to the effects on the environment of the proposed disposal of the licensed material, and commits the licensee to follow specific procedures to minimize the risk of unexpected or hazardous exposures. In the FES, the NRC staff considered the potential effects on the environment of licensed material from operation of the plant and, in the assessment of the total radiological impact of the Vermont Yankee Station concluded that: "...operation of the Station will contribute only an extremely small increment to the radiation dose that area residents receive from natural background. Since fluctuations of the background dose may be expected to exceed the increment contributed by the plant, the dose will be immeasurable in itself and will constitute no meaningful risk to be balanced against the benefits of the plant."

Since the disposal proposed by the licensee involves licensed material containing less than 0.1 percent of the radioactive materials, primarily cobalt-60 and cesium-137, already considered acceptable in the FES, and involves exposure pathways much less significant than those considered in the FES, we consider the site-specific application (Reference (a)) for Vermont Yankee Nuclear Power Station to have insignificant radiological impact. We accept the commitments and evaluations of the licensee, documented in reference (a), as further assurance that the proposed disposal procedures will have a negligible effect on the environment and the general population in comparison to normal background radiation.

LAI 855 In conclusion, we find the licensee's procedures with commitments as documented in reference (a) to be acceptable, provided that reference (a) is permanently incorporated into the licensee's Offsite Dose Calculation Manual (ODCM) as an Appendix, and future modifications of reference (a) be reported to NRC in accordance with licensee commitments regarding ODCM changes.

Pursuant to 10 CFR 51.22(c)(9), no environmental assessment is required. This completes our review under TAC No.73776.

Sincerely,

Morton B. Fairtile

Morton B. Fairtile, Project Manager
Project Directorate I-3 Division of
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cc: See next page

Revision 9 Date 3/2/90

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Adjudicatory File (2)
Atomic Safety and Licensing Board Panel Docket
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

(25)

VERMONT YANKEE
NUCLEAR POWER CORPORATION

Ferry Road, Brattleboro, VT 05301-7002

REPLY TO
ENGINEERING OFFICE
580 MAIN STREET
BOLTON, MA 01740
(508) 779-6711

June 28, 1989
BVY 89-59

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Document Control Desk

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

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

Dear Sir:

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

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

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

Revision 9 Date 3/2/90

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

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

Very truly yours,

VERMONT YANKEE NUCLEAR POWER CORPORATION

Robert W. Capstick, Jr.
Licensing Engineer

MSS/emd

Enclosures

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

ATTACHMENT 1

VERMONT YANKEE NUCLEAR POWER PLANT

APPLICATION FOR APPROVAL TO ROUTINELY DISPOSE OF

SEPTIC WASTE WITH MINIMAL LEVELS OF RADIOACTIVITY

ATTACHMENT 1

VERMONT YANKEE NUCLEAR POWER PLANT

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

1.0 INTRODUCTION

Vermont Yankee Nuclear Power Corporation (Vermont Yankee) requests approval, pursuant to 10CFR20.302(a), of a method proposed herein for the routine disposal of slightly contaminated septic tank waste. Vermont Yankee proposes to dispose of this waste by spreading it on designated areas within the plant's site boundary fence. This application addresses specific information requested in 10CFR20.302(a).

2.0 WASTE STREAM DESCRIPTION

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

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

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

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

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

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

	Isotope	Activity Concentration ±1 Sigma (pCi/kg Wet)
COB Sludge (June 8, 1988)	Cs-137	10.3 ± 1.8
	Co-60	45.4 ± 3.1
Main Tank Sludge (June 8, 1988)	Mn-54	39.3 ± 4.3
	Co-60	853.0 ± 12.0
	Zn-65	52.7 ± 8.2
	Cs-134	13.0 ± 2.2
	Cs-137	120.7 ± 5.2

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

Relative Isotopic Distributions

Isotope	In-Plant Smears	Main Tank Sludge
Mn-54	3.6%	3.6%
Co-60	81.5	79.1
Zn-65	3.8	4.9
Cs-134	0.4	1.2
Cs-137	10.3	11.2

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

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

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

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

$$W_{sol} = 14{,}950\ [gal] \times 3{,}785.4\ [cc/gal] \times 10^{-3}\ [kg/cc] \times 0.30\ [solids\ fraction] \times (1/25.4)\ [dry/wet\ ratio] \sim 700\ [kg]\ per\ pump\text{-}out\ of\ both\ tanks$$

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

3.0 DISPOSAL METHOD

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

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

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

3.1 Septic Waste Disposal Procedure

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

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

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

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

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

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

Isotope	Maximum Accumulated Radioactivity Allowed Per Acre Q_i^{lim} [μCi]
Mn-54	1.4
Co-60	120.0
Zn-65	1.4
Cs-134	0.7
Cs-137	46.5

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

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

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

- o During surface spreading or injection, the septage, and any precipitation falling onto or flowing onto the disposal field, shall not overflow the perimeter of the designated area.

- o Septage shall not be surface spread or injected into the top 6-inch soil layer within 300 feet from any drinking water well supply.

- o Septage shall not be surface spread closer than 300 feet from the nearest dwelling or public building (or within 100 feet if injected into the top 6-inch surface layer).

- o Septage shall not be surface spread closer than 50 feet (or within 25 feet if injected into the top 6-inch surface layer) from any roads or site boundary adjacent to land areas.

- o Septage shall not be surface spread within 100 feet (or within 50 feet if injected into the top 6-inch surface layer) of any surface water (rivers, streams, drainage ditches).

- o Low areas of the approved fields, subject to seasonally high groundwater levels, are excluded from the septage application.

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

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

3.2 Administrative Procedures

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

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

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

4.0 EVALUATION OF ENVIRONMENTAL IMPACT

4.1 Site Characteristics

4.1.1 Site Topography

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

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

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

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

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

4.1.2 Site Geology

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

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

4.2 Area Characteristics

4.2.1 Meteorology

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

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

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

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

4.2.2 Hydrology

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

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

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

4.2.2 Hydrology

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

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

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

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

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

4.3 Water Usage

4.3.1 Surface Water

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

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

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

4.3.2 Groundwater

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

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

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

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

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

TABLE 1

Radionuclide Travel Times

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

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

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

4.4 Land Use

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

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

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

4.5 Radiological Impact

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

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

(a) Standing on contaminated ground,

(b) Inhalation of resuspended radioactivity,

(c) Ingestion of leafy vegetables,

(d) Ingestion of stored vegetables,

(f) Ingestion of meat, and

(g) Ingestion of milk.

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

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

(b) The septic tanks are emptied every two to three years. (The assumed practice is to pump septic tanks once per year. The actual practice may be to pump septic tanks every two to three years.)

(c) The tank radioactivity remains constant at the currently determined level. To account for the uncertainty associated with the counting statistics, the measured activity concentrations listed in Section 2 were increased by 3 sigmas. That is, the activity concentrations employed in dose assessment and the total radioactivity content per pump-out (at 700 kg of solids per batch) are as follows:

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

(d) The radiation source corresponds to the accumulation of radioactive material on a single plot (two-acre) within the proposed disposal sites over a period of 20 years (40 applications at 6-month intervals). (In actuality, the proposed sites will accommodate more than one disposal plot, and, in practice, more than one plot will most probably be used with an application frequency of once per year.)

(e) For the analysis of the radiological impact during Vermont Yankee active control of the disposal sites, all dispersed radioactive material remains on the surface and forms a source of unshielded radiation. (In practice, the septic waste will be either surface spread or directly injected within the top 6 inches of the disposal plot, in which case, the radioactive material will be mixed with the soil. This, in effect, would reduce the ground plane source of exposure by a factor of about four due to self-shielding.)

(f) No radioactive material is dispersed directly on crops for human or animal consumption, crop contamination being only through root uptake.

(g) The deposition on crops of resuspended radioactivity is insignificantly small.

(h) Pathway data and usage factors used in the analysis are the same as those used in the plant's ODCM assessment of the off-site radiological impact from routine releases,with the exception that the fraction of stored vegetables grown on the disposal plots was conservatively increased from 0.76 to 1.0 (at present no vegetable crops for direct human consumption are grown on any of the proposed disposal plots).

(i) It is conservatively assumed that Vermont Yankee relinquishes control of the disposal sites after the fortieth pump-out (i.e., the above source term applies also for the inadvertent intruder).

(j) For the analysis of the impact after Vermont Yankee control of the sites is relinquished, the radioactive material is plowed under and forms a uniform mix with the top six inches of soil; but, nonetheless, undergoes resuspension at the same rate as surface contamination.

From radiological impact assessments associated with the disposal of septage on different plot sizes (Attachment 2), it was determined that a single two-acre plot within the disposal sites would accommodate the 1 mrem/year prescribed dose to the critical organ of the maximally exposed individual for a period of up to 20 years, as well as the 5 mrem/year prescribed dose to the inadvertent intruder after control is assumed to be relinquished. The calculated potential radiation exposures following the spreading of 40 combined (main septic system and south disposal system) tankfuls (at six-month intervals) on a single two-acre plot are as follows:

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

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

Pathway-Dependent Critical Organ Doses

Pathway	Maximally Exposed Individual/Organ (Child/Liver) (mrem/year)	Inadvertent Intruder Critical Individual/Organ (Teenager/Lung) (mrem/year)
Ground Irradiation	0.0576	1.16
Inhalation	0.00122	2.74
Stored Vegetables	0.0913	0.00601
Leafy Vegetable	0.00467	0.00040
Milk Ingestion	0.0421	0.00229
Meat Ingestion	0.00249	0.00012
TOTAL	0.1994	3.909

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

Isotopic Breakdown of Maximum Radiation Exposures

Description	Isotope	Radioactivity [μCi/2 Acres]	Exposure [mrem/yr]
During Vermont Yankee control of the disposal sites. Maximally Exposed Individual/Organ: Child/Liver	Mn-54	2.831	0.000436
	Co-60	235.3	0.0559
	Zn-65	2.801	0.0230
	Cs-134	1.457	0.00231
	Cs-137	92.59	0.118
	TOTAL		0.199
After Vermont Yankee control of sites is relinquished. Inadvertent Intruder Critical Individual/ Organ: Teenager/Lung	Mn-54	2.831	0.0144
	Co-60	235.3	3.76
	Zn-65	2.801	0.00983
	Cs-134	1.457	0.000505
	Cs-137	92.59	0.1247
	TOTAL		3.91

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

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

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

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

5.0 RADIATION PROTECTION

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

REFERENCES

1. Flood Insurance Study, Vernon, Vermont, Windham County, FEMA, Community No. 500137, July 25, 1980.

2. Flood Insurance Study, Town of Hinsdale, New Hampshire, Cheshire County, FEMA, Community No. 330022, October 15, 1980.

3. Vermont Yankee Well Development Evaluation by Wagner, Heindel, and Noyes, Inc. July 10, 1986.

4. NUREG/CR-3130, Influence of Leach Rate and Other Parameters on Groundwater Migration, by Dames & Moore, February 1983.

5. Vermont Yankee Nuclear Power Corporation On-Site Septage Disposal Plan, by Wagner, Heindel, and Noyes, Incorporated, June 1989.

FIGURE 1
MAIN SEPTIC TANK

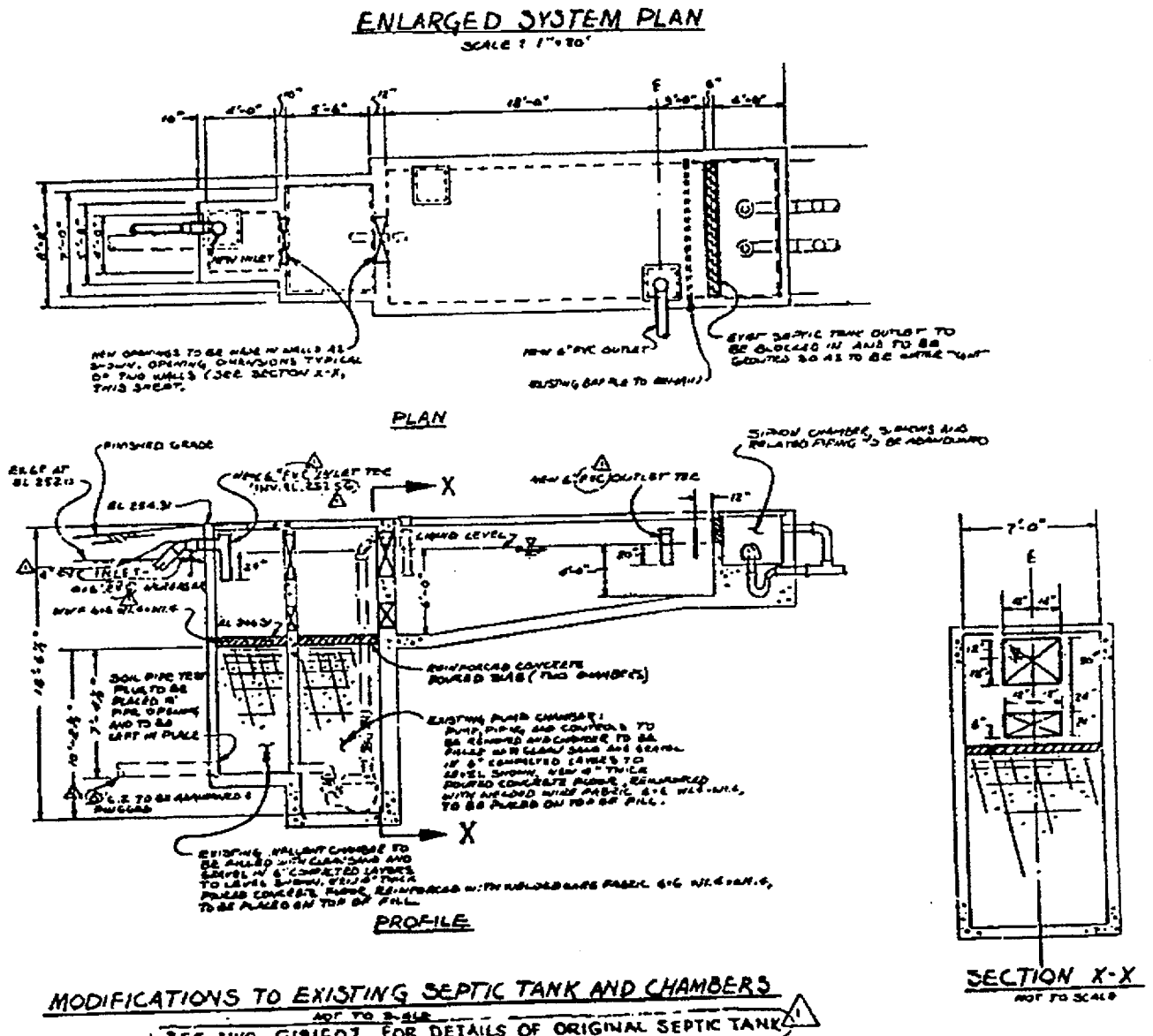


FIGURE 2
SOUTH DISPOSAL SYSTEM
SEPTIC TANK

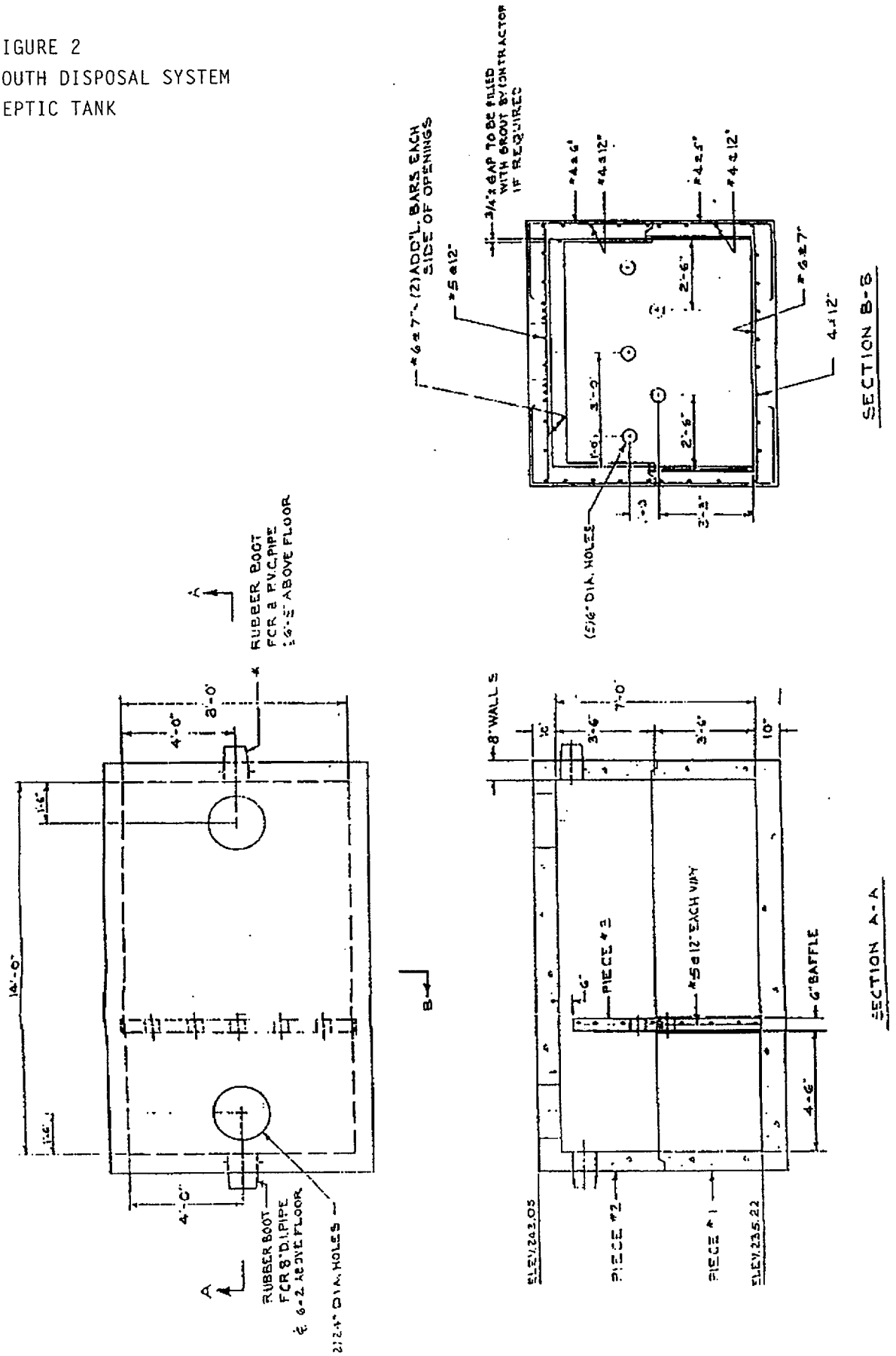


FIGURE 3
POTABLE AND WASTE WATER FLOW

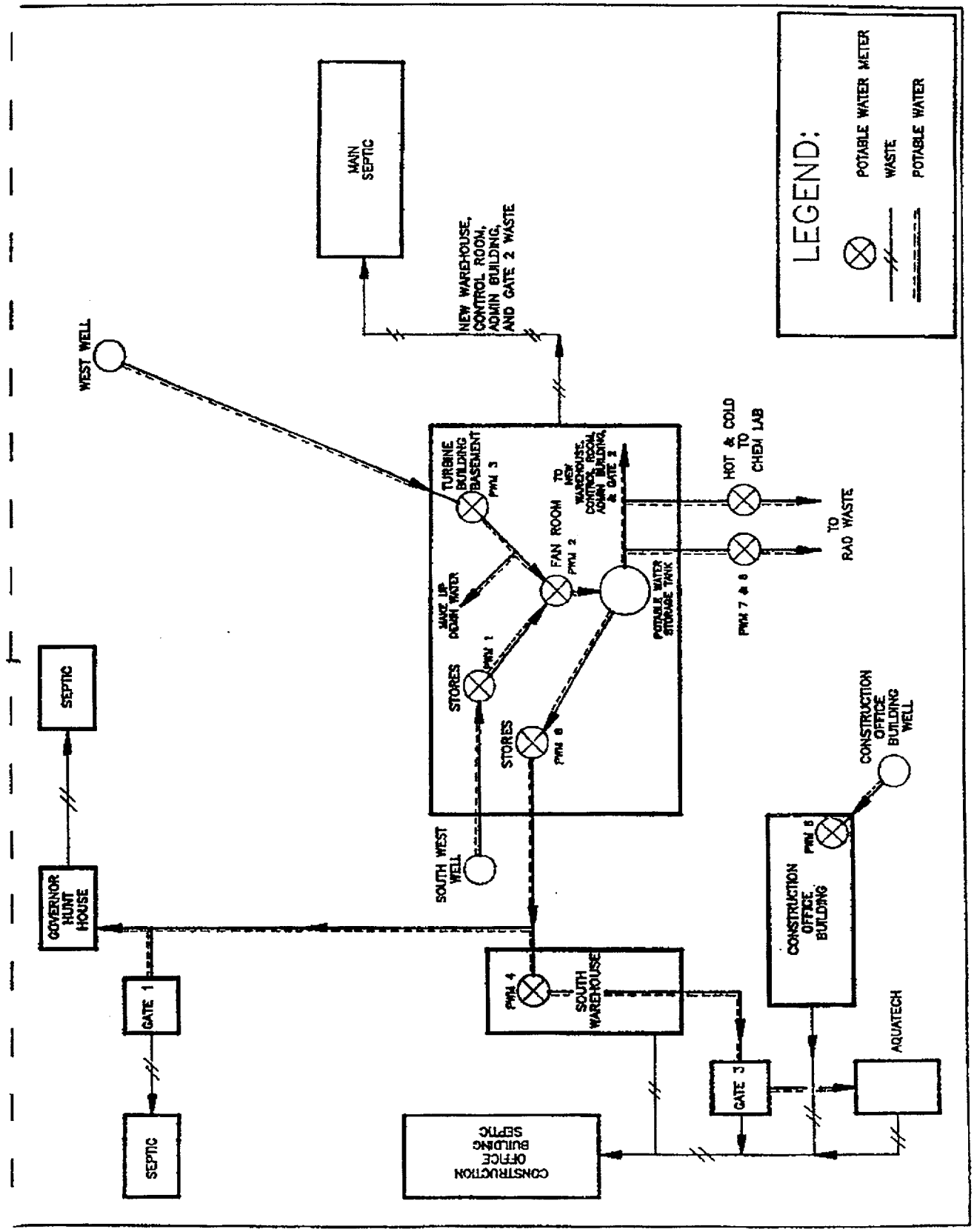
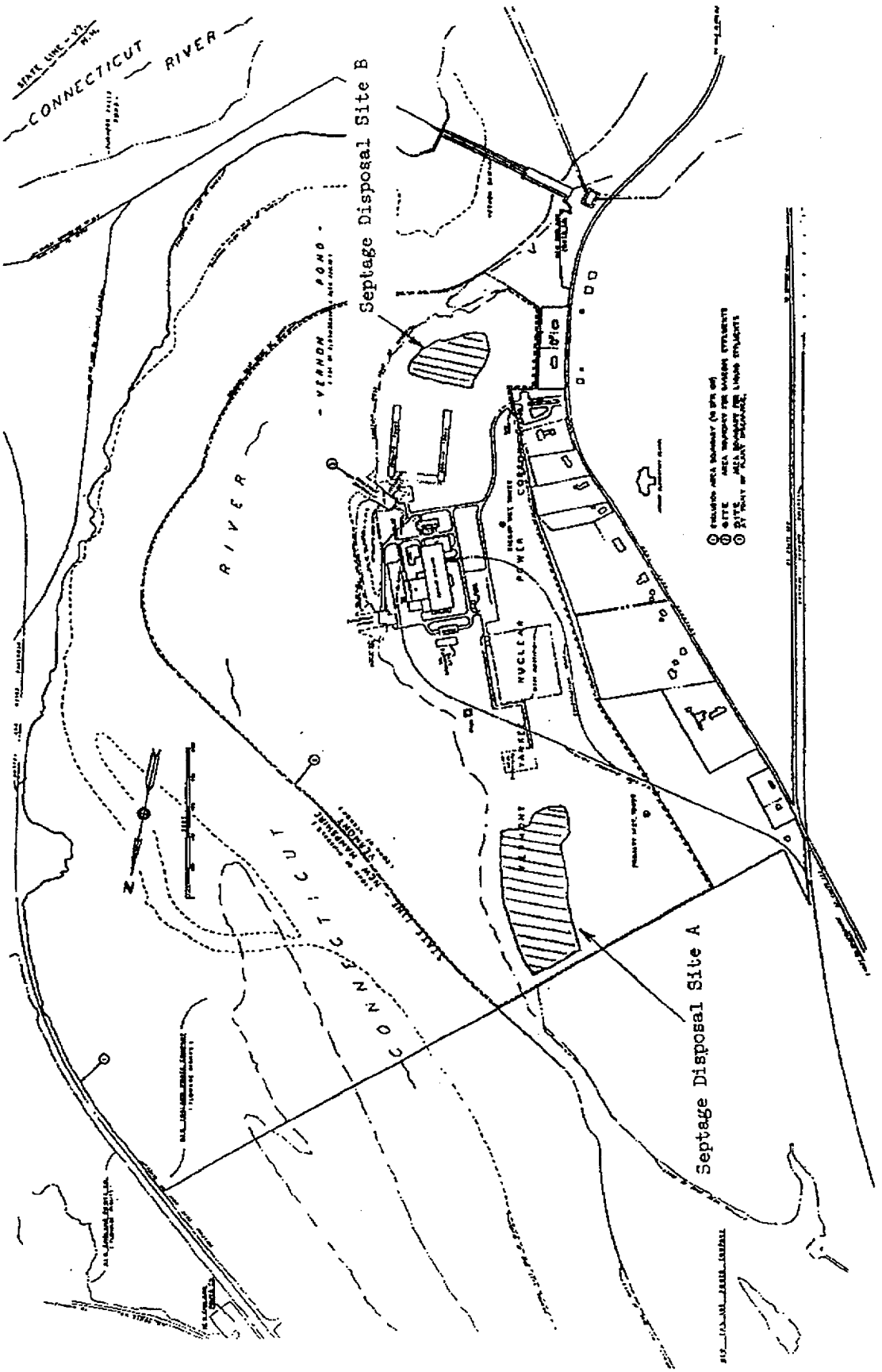


FIGURE 4
SEPTIC WASTE DISPOSAL AREAS



(This attachment to Appendix B is incorporated into the ODCM by reference due to size. A complete copy is on file with Vermont Yankee Document Control as part of Correspondence Letter BVY 89-59.)

ATTACHMENT 2

VERMONT YANKEE NUCLEAR POWER PLANT

RADIOLOGICAL ASSESSMENT OF

ON-SITE DISPOSAL OF SEPTIC WASTE

and

PROPOSED PROCEDURAL CONTROLS TO ENSURE

COMPLIANCE WITH RADIOLOGICAL LIMITS

APPENDIX D

ASSESSMENT OF SURVEILLANCE CRITERIA FOR GAS RELEASES FROM WASTE OIL INCINERATION

APPENDIX D

ASSESSMENT OF SURVEILLANCE CRITERIA FOR GAS RELEASES FROM WASTE OIL INCINERATION

INTRODUCTION:

The Nuclear Regulatory Commission amended its regulations (10CFR20) in a Federal Register Notice (Vol. 57, No. 235; page 57649 / Monday, December 7, 1992) that permitted the on-site incineration of contaminated waste oil generated at licensed nuclear power plants without the need to amend existing operating licenses. This action will help to ensure that the limited capacity of licensed low level waste disposal facilities is used efficiently while maintaining releases from operating nuclear power plants at levels which are "as low as reasonably achievable." Incineration of this class of waste must be in full compliance with the Commission's current regulations that restrict the release of radioactive materials to the environment. Any other applicable Federal, State, or local requirements that relate to the toxic or hazardous characteristics of the waste oil would also have to be satisfied.

Incineration of waste oil is to be carried out under existing effluent limits, recordkeeping and reporting requirements. Specifically, licensees must comply with the effluent release limitations of 10CFR Part 20, and Part 50; Appendix I. This includes the site gaseous pathway dose and dose rate limits contained in the plant's Technical Specifications (Section 3.8). The dose contribution to members of the public resulting from the on-site incineration of contaminated waste oil must not cause the total dose or dose rate from all effluent sources to exceed the dose or concentration limits imposed by 10CFR20, 10CFR50; Appendix I, and the Radiological Effluent Technical Specifications (RETS). It is expected that the actual contribution to public exposures caused by waste oil burning will be a small fraction of the site's effluent limits, as well as a small portion of the total releases from the site.

SOURCE DESCRIPTION

Contaminated waste oil suitable for on-site incineration can be burned in the Waste Oil Burner located in the North Warehouse. The burner has its own exhaust stack situated on the roof of the warehouse. However, due to the short height of the exhaust stack above the roof line, this release point is considered to be a ground level point source for modeling discharges to the environment. In addition, the building wake effects from the North Warehouse are assumed to be independent of the larger Turbine Hall/Reactor Building complex due to its distance from these main structures. Consequently, the relatively small size of the North Warehouse leads to

meteorological dispersion factors that are conservative with respect to the dispersion factors for the main plant structures.

The waste oil burner is rated to process oil at a 2 gal./hour from a 500 gallon day tank. The offgas flow rate for the burner is rated as 199 cfm. This provides an air to oil dilution during the incineration of 44,800.

WASTE OIL SAMPLING/SURVEILLANCE REQUIREMENTS

The oil burner stack is not equipped with continuous air monitoring or sampling capability for the direct determination of radiological effluent releases during the incineration process. As a consequence, sampling and analysis of the waste oil prior to its incineration is necessary to project the dose and dose rate consequences of burning contaminated oil. Calculations of projected dose from the incineration of total quantity of oil to be added to the Waste Oil Burn Day Tank for each series of burns will be performed in accordance with the methods in the ODCM and compared to the accumulated site total dose for that period before initiation of incineration. Dose rate determinations will be determined by averaging the projected dose for the quantity of radioactivity determined to be present in the oil over the expected duration of the burn necessary to incinerate the total volume to be added to the Day Tank. Inherent in this determination is the assumption that all radioactivity found to be present in each batch of oil will be released to the atmosphere during the incineration. No retention of activity in the combustion chamber is assumed in calculating the offsite radiological impact.

Normal sampling and analysis methods for gaseous release streams cannot be applied directly to liquids (waste oil). Therefore, the sampling and analysis requirements for liquids as identified in Technical Specification Table 4.8.1 shall be used to determine the level of contamination in waste oil. The stated Lower Limits of Detection (LLD) given on Table 4.8.1 provide assurance that undetectable levels of contamination up to the LLD values will not result in a significant dose impact to the maximum offsite receptor. If waste oil was burned continuously for an entire calendar quarter, and the radionuclides listed in the ODCM Dose Conversion Factor Table 1.1-12 were assumed to be present in the oil at the LLD values specified in Technical Specification Table 4.8.1, the resultant maximum organ dose would amount to only 0.28% of the ALARA quarterly limit of 7.5 mrem.

The principle limitation in the incineration of waste oil is that the site release limits contained in RETS, and implemented by the ODCM methodology, shall not be exceeded. The use of the liquid LLDs on waste oil sample analyses provide sufficient sensitivity to ensure that site dose limits will not be exceeded as a consequence of burning slightly contaminated oil.

APPENDIX F

APPROVAL PURSUANT TO 10CFR20.2002
FOR ONSITE DISPOSAL OF COOLING TOWER SILT

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 18, 1997
NVY 97-85

LAI 1130, 1210, 1193

Mr. Donald A. Reid
Vice President, Operations
Vermont Yankee Nuclear Power Corporation
Ferry Road
Brattleboro, VT 05301

SUBJECT: REVISED SAFETY EVALUATION - APPROVAL PURSUANT TO 10 CFR 20.2002 FOR ONSITE DISPOSAL OF COOLING TOWER SILT - VERMONT YANKEE NUCLEAR POWER STATION (TAC NO. M96371)

Dear Mr. Reid:

By letter dated August 30, 1995, Vermont Yankee Nuclear Power Corporation (VYNPC) requested approval, pursuant to 10 CFR 20.2002, for the onsite disposal of slightly contaminated silt material removed from Vermont Yankee Nuclear Power Station's (Vermont Yankee's) cooling towers. In a safety evaluation (SE) dated March 4, 1996, the NRC staff approved the proposed silt disposal. However, because of discrepancies VYNPC identified between the safety evaluation and VYNPC's letter of August 30, 1995, VYNPC postponed implementation of the silt disposal until resolution of the discrepancies. By letter dated August 2, 1996, VYNPC informed the NRC staff of the discrepancies and requested that the SE be revised accordingly. Recognizing the discrepancies, the NRC staff has prepared the enclosed SE to resolve the discrepancies and to replace the SE of March 4, 1996.

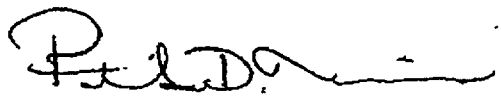
LAI 1130 | The NRC staff's approval of VYNPC's silt disposal request is granted provided the enclosed replacement SE is permanently incorporated into Vermont Yankee's Offsite Dose Calculation Manual as an appendix. Any modification to the proposed action that may be considered in the future must have prior NRC staff approval

Pursuant to the provisions of 10 CFR Part 51, the Commission has published in the Federal Register an Environmental Assessment and Finding of No Significant Impact (61 FR 6662).

Revision 21 Date 08/14/97

If you have any further questions regarding this matter, please contact Mr. Kahtan Jabbour at (301) 415-1496.

Sincerely,



Patrick D. Milano, Acting Director
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Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosure: Safety Evaluation

cc w/encl: See next page

cc:

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Revision 21 Date 08/14/97

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ONSITE DISPOSAL OF SLIGHTLY CONTAMINATED COOLING TOWER SILT

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

DOCKET NO. 50-271

1.0 INTRODUCTION

By letter dated August 30, 1995, Vermont Yankee Nuclear Power Corporation (VYNPC) requested approval for the onsite disposal of slightly contaminated silt material removed from Vermont Yankee Nuclear Power Station's (Vermont Yankee's) cooling towers. In a safety evaluation (SE) dated March 4, 1996, the NRC staff approved the proposed silt disposal. However, because of discrepancies between the SE and VYNPC's letter of August 30, 1995, VYNPC postponed implementation of the silt disposal until resolution of the discrepancies. By letter dated August 2, 1996, VYNPC informed the NRC staff of the discrepancies and requested that the SE be revised accordingly. Recognizing the discrepancies, the NRC staff has prepared this SE to resolve the discrepancies and to replace the SE of March 4, 1996.

2.0 BACKGROUND

VYNPC has previously obtained NRC staff approval of the onsite disposal of very-low-level radioactive material similar to the proposed silt disposal. By letter dated June 28, 1989, VYNPC proposed the onsite disposal of slightly contaminated septic waste material by land application at Vermont Yankee. By letter dated August 30, 1989, the NRC staff approved this request pursuant to 10 CFR 20.302 (now 10 CFR 20.2002). The NRC staff considered this site-specific application for Vermont Yankee to have insignificant radiological impact because the proposed septic waste material disposal involved licensed material containing less than 0.1 percent of the radioactive material, primarily cobalt-60 and cesium-137, already considered acceptable in the Final Environmental Statement (FES) of July 1972, and involved exposure pathways much less significant than those in the FES. In addition, the proposed septic waste material disposal satisfied the following applicable boundary conditions for the disposal of licensed material:

a. The whole body dose to the hypothetical maximally exposed individual must be less than 1.0 mrem/year.

b. Doses to the whole body and any organ of an inadvertent intruder from the probable pathways of exposure are less than 5 mrem/year.

c. The disposal must be at the same site.

Following the NRC staff's approval on August 30, 1989, VYNPC implemented the disposal of the contaminated septic waste material as proposed.

By letter dated August 30, 1995, VYNPC requested that the previous authorization for the onsite disposal of very-low-level radioactive material be amended to permit the onsite disposal of slightly contaminated silt material, within the boundary conditions of the previously approved septic waste material disposal.

3.0 EVALUATION

In its letter of August 30, 1995, VYNPC stated that the proposed silt disposal method is the same as the previously approved septic waste disposal method, and utilizes land spreading in the same onsite areas approved for septic waste disposal. The volume of silt proposed for onsite disposal consists of 14,000 cubic feet (396 cubic meters) accumulated through August 1995 plus approximately 4,000 cubic feet (113 cubic meters) to be removed from the cooling towers during each 18-month operating cycle. The activity contained in the currently accumulated silt, based on samples taken by VYNPC in June 1995, is 0.193 millicuries, principally from 0.034 millicuries of cobalt-60 and 0.159 millicuries of cesium-137. The activity contained in the additional silt to be removed from the cooling towers each 18-month operating cycle is anticipated to be 0.059 millicuries, principally from 0.012 millicuries of cobalt-60 and 0.047 millicuries of cesium-137.

VYNPC's radiological assessment enclosed with its August 30, 1995, letter demonstrates that the combined radiological impact for all onsite disposal operations, the proposed disposal of silt and the previously approved disposal of septic waste material, will continue to meet the applicable boundary conditions (given above) for the disposal of licensed material. Therefore, the proposed onsite disposal of slightly contaminated silt is acceptable.

As discussed in VYNPC's letter of August 2, 1996, if the onsite disposal of cooling tower silt or septic waste material would result in exceeding the applicable boundary conditions (given above), then VYNPC must obtain prior NRC staff approval of the disposal. In addition, VYNPC made the following commitments:

LAI 1193 1130

a. VYNPC will report in the Annual Radiological Effluent Release Report a list of the radionuclides present and the total radioactivity associated with the onsite disposal activities at Vermont Yankee.

AI 1130 b. VYNPC will maintain records of radionuclide concentrations and total activity associated with onsite disposal activities at Vermont Yankee in accordance with 10 CFR 50.75(g).

4.0 CONCLUSION

The NRC staff finds that the radiological conditions at the Vermont Yankee site (see attachment) that would result from the onsite disposal of slightly contaminated silt material, as proposed by VYNPC pursuant to 10 CFR 20.2002, and the previously approved onsite disposal of slightly contaminated septic waste material, are within the applicable boundary conditions (given above) for the disposal of licensed material. Therefore, the proposed onsite disposal of slightly contaminated silt removed from Vermont Yankee's cooling towers is acceptable.

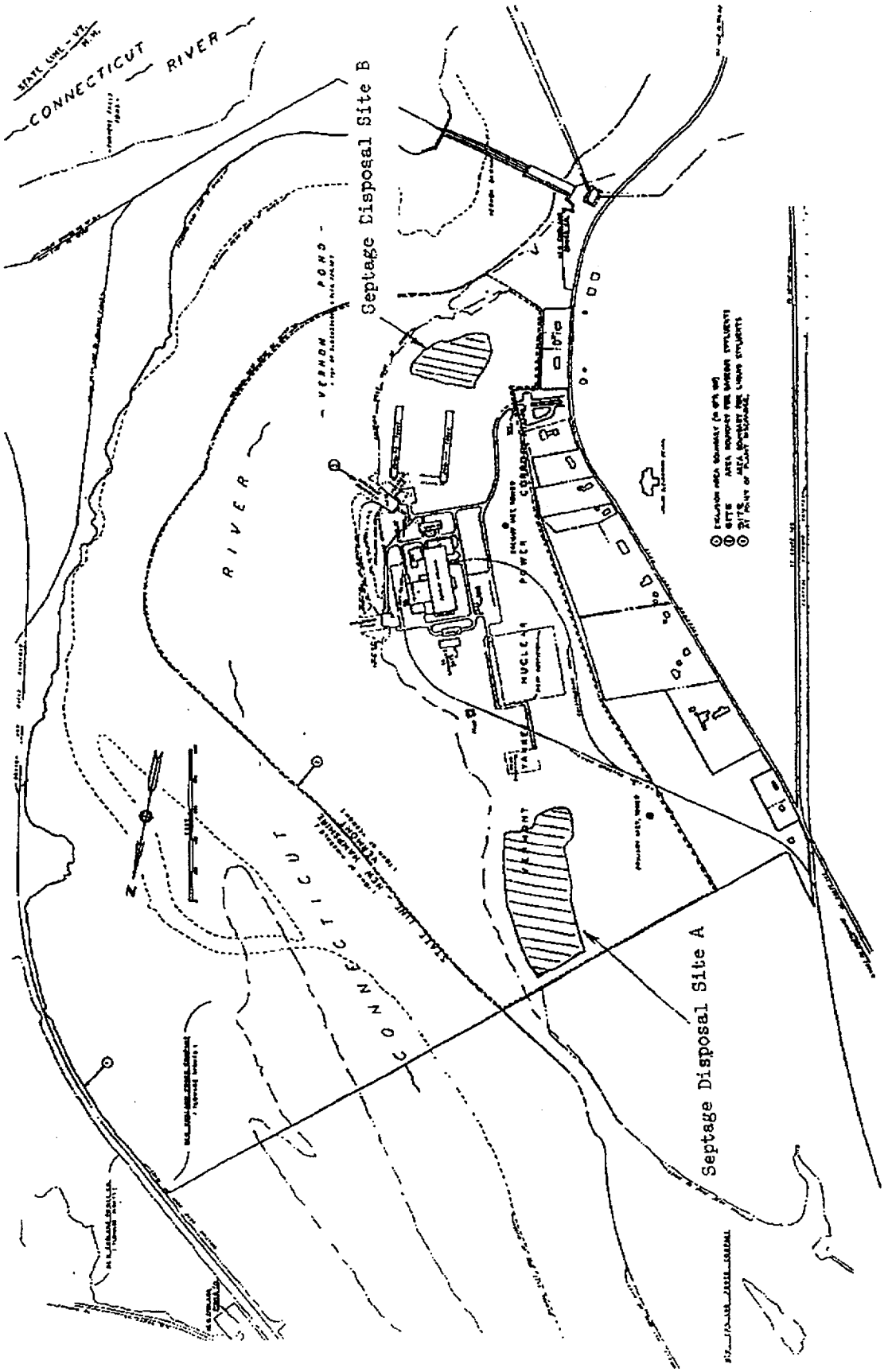
LAI 1130 VYNPC is required to permanently incorporate this SE into the Vermont Yankee Offsite Dose Calculation Manual as an Appendix to document the the radioactive material onsite disposal activities approved for Vermont Yankee, and VYNPC's related commitments regarding reporting and record keeping. Any additional modification of VYNPC's disposal activities which go beyond those proposed in the August 30, 1995, submittal, and are not addressed above must have prior NRC staff approval. In addition, any onsite disposal of cooling tower silt or septic waste material that would result in exceeding the applicable boundary conditions (given above), must also have prior NRC staff approval.

Principal Contributors: J. Minns
D. Dorman
C. Harbuck

Date: June 18, 1997

Attachment: Vermont Yankee Site Area Map

FIGURE 4
SEPTIC WASTE DISPOSAL AREAS



VERMONT YANKEE
NUCLEAR POWER CORPORATION

Ferry Road, Brattleboro, VT 05301-7002

REPLY TO
ENGINEERING OFFICE
580 MAIN STREET
BOLTON, MA 01740
(508) 779-6711

RESPONSIBILITY
LAS 10/44 CLOSED

August 30, 1995
BVY 95-97

United States Nuclear Regulatory Commission
Washington, DC 20555

ATTN: Document Control Desk

References: (1) License No. DPR-28 (Docket No. 50-271)
(2) Letter from R. W. Capstick, Vermont Yankee, to USNRC, "Request to Routinely Dispose of Slightly Contaminated waste in Accordance with 10CFR20.302(a)", BVY 89-59, June 18, 1989.
(3) Letter from M. B. Fairtile, USNRC, to L. A. Tremblay, Vermont Yankee, "Approval Under 10 CFR 20.302(a) of Procedures for Disposal of Slightly Contaminated Septic Waste on Site at Vermont Yankee (TAC No. 73776)", dated August 30, 1989.

Subject: Request to Amend Previous Approval Granted Under 10 CFR 20.302(a) for Disposal of Contaminated Septic Waste

In accordance with the criteria of the Code of Federal Regulations, Title 10, Section 20.2002 (previously cited 10CFR20.302(a)), enclosed please find the subject application to amend the previously granted approval (Reference 3) to dispose of slightly contaminated septic waste on site at Vermont Yankee by expanding the allowable waste stream to include slightly contaminated Cooling Tower silt material.

This application specifically requests approval to dispose of Cooling Tower silt deposits, contaminated at minimal levels, which have been or might be generated through the end of station operations at the Vermont Yankee Nuclear Power Plant. The proposed silt disposal method is the same as the septic waste disposal method requested in Reference 2 and approved in Reference 3. The disposal method utilizes on site land spreading in the same designated areas used for septic waste. Disposal of this waste in the manner proposed, rather than holding it for future disposal at a 10CFR Part 61 licensed facility when access to one becomes available, will save substantial costs and valuable disposal site space for waste of higher radioactivity levels.

A radiological assessment and proposed operational controls based on continued on site disposal of accumulated river silt removed from the basins of the plant's mechanical draft cooling towers is contained in Enclosure A. The assessment demonstrates that the dose impact expected from the disposal of silt removed from the cooling towers during normal maintenance will not exceed the dose limits already imposed for septic waste disposal. The combined radiological impact for all on site disposal operations shall be limited to a total body or organ dose of a maximally exposed member of the public of less than one mrem/year during the period of active Vermont Yankee control of the site, or less than five mrem/year to an inadvertent intruder after termination of active site control. Enclosure B contains a copy of the original assessment and disposal procedures for

septic waste (References 2 and 3) for your use and reference in evaluating the proposed amendment.

Upon receipt of your approval, Enclosure A will be incorporated into the Vermont Yankee ODCM.

LAI 1044 Closed

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

Sincerely,

VERMONT YANKEE NUCLEAR POWER CORPORATION

James J. Duffy
Licensing Engineer

Enclosures A & B

c: USNRC Region I Administrator (Letter and Enclosure A)
USNRC Resident Inspector - VYNPS (Letter and Enclosure A)
USNRC Project Manager - VYNPS (Letter and Enclosure A)

ENCLOSURE A

VERMONT YANKEE NUCLEAR POWER PLANT

ASSESSMENT OF ROUTINE DISPOSAL OF COOLING TOWER SILT IN AREAS ON SITE PREVIOUSLY DESIGNATED FOR SEPTIC WASTE DISPOSAL

Table of Contents

VERMONT YANKEE NUCLEAR POWER PLANT

Assessment of Routine Disposal of Cooling Tower Silt in Areas On-Site Previously Designated for Septic Waste Disposal

1.0 INTRODUCTION:

Vermont Yankee Nuclear Power Corporation (Vermont Yankee) requested from the NRC in 1989 permission to routinely dispose of slightly contaminated septic waste in designated on-site areas in accordance with 10CFR20.302(a). The NRC responded to this request on August 30, 1989 by granting approval of the proposed procedures for on-site disposal of septic waste concluding that the commitments, as documented in our request, were acceptable provided that our request and analysis be permanently incorporated into the plant's Offsite Dose Calculation Manual (ODCM). Revision 9 to the ODCM (Appendix B) incorporated the assessment and approval of the methods utilized for on-site disposal of slightly contaminated sewage sludge.

In addition to the previously identified solids content of septic waste as a source of environmental, low level radioactive contaminated material, cooling tower silt deposits resulting from the settling of solids from river water passing through the mechanical draft cooling tower system have been identified to also contain low levels of plant-specific radionuclides. Periodic removal of the silt from the cooling tower basins is a necessary maintenance practice to insure operability of the cooling system. However, due to the presence of by-product materials in the silt, proper disposal requirements must be applied to insure that the potential radiological impact is within acceptable limits.

This assessment of silt disposal expands the original septic waste disposal assessment to include earthen type materials (cooling tower silt deposits) while maintaining the original radiological assessment modeling and dose limit criteria that have been approved for septic waste spreading on site. This assessment demonstrates that cooling tower silt can be disposed of in the same manner and under the same dose limit criteria as previously approved for septic waste in Appendix B to the Vermont Yankee ODCM. Implementation of the following commitments as an amendment to the original 10 CFR

Part 20.302(a) approval for septic waste shall be incorporated into the Vermont Yankee ODCM upon approval by the NRC.

2.0 WASTE STREAM DESCRIPTION:

The waste involved in this assessment is residual solids (silt) collected in the basins of the plant's mechanical draft cooling tower system. The silt consists of organic and inorganic sediments and earthen type materials that have settled from the cooling water flow taken from the Connecticut River as it passes through the towers. As a result of de-sludging the tower basins in 1993, an estimated 14,000 cubic feet of silt was accumulated on site. Clean-out operations will also occur periodically to ensure continued system operability. Sample analysis performed to the plant's environmental lower limits of detection requirements, as contained in Technical Specification Table 4.9.3., has identified Cobalt-60 and Cesium-137 in low concentrations as being present in silt collected in 1993.

The cooling towers are located at the southern end of the plant facility complex but are not directly connected to any system in the plant that contains radioactivity. The postulated mechanism of how plant-related radionuclides have been introduced into the cooling system silt assumes that past routine effluents discharged from nearby plant gaseous release points were entrained in the large mechanically-induced air flow that is pulled through the towers as a heat exchange medium. The cooling water flow provides a scrubbing action as it is breaks up into fine water droplets due to the splash pans of the towers. This scrubbing action washes any airborne particulates out of the air. Over long periods of operation, any radioactivity removed from the air flow could buildup to measurable levels in silt that settles out in the basins at the bottom of the towers.

Table 1 lists the analyses of twenty-one samples collected from the silt pile removed from the cooling tower basins. Radioactivity measurements, averaged over all the samples, indicate that the silt material can be characterized as containing approximately 50 pCi/kg (dry wt.) of Cobalt-60 and 198 pCi/kg (dry wt.) of Cesium-137. Eight of the samples indicated no positive Cobalt-60 above a minimum detectable level achieved for the analysis.

Table 1

Cooling Tower Silt Radioactivity
(1993 samples*)

Sample #	Co-60 (pCi/kg dry)	Cs-137 (pCi/kg dry)
G12759	53	144
G12758	72	172
G12757	<14	201
G12756	<17	245
G12755	73	206
G12754	<16	165
G12753	<27	240
G12752	79	181
G12751	<29	180
G12750	35	107
G12749	59	171
G12748	<19	205
G12747	<38	209
G12746	< 7	218
G12745	50	241
G12744	40	220
G12743	68	264
G12742	45	195
G12724	71	115
G12723	104	264
G13940	126	218
Average:	50	198
Max.	126	264
Min.	< 7	107
Standard deviation:	30	42

* Average wet to dry sample weight ratio equal to 1.6. Dry weight silt density equal to 1.3 gm/cc.

For the purpose of estimating the total activity in the silt pile, the less than values in Table 1 are included as positives in the calculation of the average radioactivity concentration.

Cobalt-60, due to its relatively short half life, is typically associated with plant operations when measured in the near environment. However, Cesium-137 when measured in the environment may have a background component that is not related to power plant operations. Past weapons testing fallout has imposed a man made background level of Cesium-137 in New England soils and sediments that can vary over several hundred pCi/kg. The plant's Environmental Monitoring Program has shown that Connecticut River sediment in the vicinity of Vermont Yankee averages about 123 pCi/kg (dry wt.) of Cesium-137 (Table 2) with no plant related detectable level of Cobalt-60. The value of 123 pCi/kg may represent an estimate of background level of Cesium-137 in sediment that would be subject to entrainment in cooling water flow that enters the plant. In comparing the measured levels of Cesium-137 on Table 1 with the past river sediment level, the average concentration in the cooling tower silt is higher than that of the river sediment data but does fall within the observed range of recorded sediment Cs-137. The river sediment Cesium-137 concentration averages about 62% of the concentration value detected in the tower silt. For purposes of this assessment of plant-related dose impact from the on-site disposal of silt material, it is conservatively assumed that all detectable Cs-137 in cooling tower silt is directly related to plant operations. No background component is subtracted from the measured values for this case study since only a single sampling location (down stream) is included in the Environmental Monitoring Program which may not fully describe the true background levels in the region.

The total radioactivity for the current 14,000 cubic feet of silt collected on site can be estimated by multiplying this volume by its "as is" density of 2.1 gm/cc (i.e. 1.3 gm/cc dry weight density x 1.6 wet/dry weight ratio) and then conservatively assume that the measured average dry weight radioactivity concentrations for Cobalt and Cesium would be the same as in the collected silt. Multiplying the average Cobalt-60 and Cesium-137 concentration in silt by the mass of the collected material produces estimates (Table 3) of total radioactivity that was removed from the cooling tower basin in September 1993.

Table 2

Cesium-137 in

Connecticut River Sediments*

Date	Cs-137 (pCi/kg dry)
05/24/94	61
10/13/93	85
06/02/93	60
10/15/92	137
05/20/92	176
10/24/91	178
05/16/91	230
10/25/90	84
05/16/90	62
10/04/89	<174
05/26/89	179
10/12/88	115
05/12/88	62
Average:	132
Max.	230
Min.	60
Standard deviation:	56

* Samples collected as part of the Vermont Yankee Radiological Environmental Monitoring Program (REMP) for river sediment sample location SE-11.

Table 3

Estimated Total Radioactive Material for 1993 Tower Clean-Out

	Volume of Silt (ft3)	Mass (kg)	Average Concentration (pCi/kg)	Total Act. (as of 11/93) (uCi)	Decayed Act. (as of 6/95) (uCi)
Co-60	14,000	8.32E+5	50	42	34
Cs-137	14,000	8.32E+5	198	165	159

In addition to 14,000 cubic feet of silt already accumulated, it is anticipated that periodic maintenance work in cleaning out the cooling tower basins will generate approximately 4,000 cubic feet of new silt material over each successive 18 month operating cycle. Assuming the same level of plant-related radioactivity concentration that was originally observed, the additional amounts of radioactivity that will require on site disposal following each refueling cycle can also be estimated. Table 4 lists an estimate of the total radioactivity that might be present at each 18 month clean-out cycle.

Table 4

Estimated Total Radioactive Material for Each 18 Month Maintenance Cycle

	Volume of Silt (ft3)	Mass (kg)	Average Concentration (pCi/kg)	Total Activity (uCi)
Co-60	4,000	2.38E+5	50	12
Cs-137	4,000	2.38E+5	198	57

3.0 DISPOSAL METHOD:

The method of silt disposal shall utilize a technique of land spreading in a manner consistent with the current commitments for the on-site disposal of septic waste as approved by the NRC and implemented as Appendix B of the Vermont Yankee ODCM (Reference 1). The same land areas designated and approved for septic waste disposal shall be used for the placement of silt removed from the cooling tower basins. Determination of the radiological dose impact shall also be made based on the same models and pathway assumptions as indicated in Appendix B of the ODCM.

3.1 Silt Disposal Procedure Requirements:

Gamma isotopic analysis of silt samples shall be made prior to each disposal by obtaining representative composite samples in sufficient numbers to characterize the material removed from the cooling tower basins. Each gamma isotopic analysis shall be required to achieve the environmental lower limits of detection as indicated for sediment on Table 4.9.3 of the Vermont Yankee Technical Specifications.

The estimation of total radioactivity to be disposed of shall be made based on the average of all composite sample analyses. The estimation of total radioactivity and projected dose impact shall be made prior to placing the collected silt on the designated disposal plots. The dose impact from each disposal operation shall be included with all past septic waste and silt spreading operations to ensure that the appropriate dose limits are not exceeded on any waste disposal area for the combination of all past operations.

The established dose criteria requires that all applications of earthen type materials within the approved designated disposal areas shall be limited to ensure that dose to a maximally exposed individual (during the Vermont Yankee control period) be maintained less than 1 mrem/year to the whole body and any organ, and the dose to an inadvertent intruder following termination of site control be maintained less than 5 mrem/year to the whole body and any organ.

The limits on concentrations of radionuclides as addressed in Appendix B to the ODCM for septic waste (i.e., each tank of septic sludge to be disposed are limited to a combined MPC ratio of less than 0.1) were included to ensure proper control was in place to address the situation of small quantities of relatively high concentration material. This limitation does not directly apply to silt deposits since the silt is handled as dewatered sediments as opposed to liquid slurries of septic waste.

For dry, earthen type material such as silt, a specific radionuclide concentration limit shall be applied in place of the septic waste liquid MPC ratio. No soil associated with a sample analysis that identifies a plant-related radionuclide in excess of the concentration limits of Table 5 will be permitted regardless of the total pathway dose assessment determined for the quantity material under consideration. For the case where more than one radionuclide is detected, the sum of the ratio rule will be applied. The measured concentration of each radionuclide divided by its limiting concentration value shall be added with the sum of all fractions equal to or less than 1. This limiting condition will prevent small volumes of relatively high specific radioactivity from being spread on the disposal plots, and therefore reduce the potential for creating unexpected hot spots of concentrated material.

Table 5 lists, by radionuclide, soil concentration values that would generate an annual external effective dose equivalent of 25 mrem/year if it were assumed that an individual continuously stood on an infinite plane of soil contaminated to a depth of 15 cm. The assumptions of an infinite plane and continuous occupancy are conservative for situations where the amount of contaminated soil identified would not provide for a 15 cm soil depth over an extended surface area and where disposal site access is limited. Twenty-five mrem/year was selected as a reference value based on the fact that it was a suitable fraction of the NRC annual dose limit (100 mrem/year per 10 CFR Part 20.1301) applied to members of the public from all station sources. The 25 mrem/year also equals the EPA dose limit from 40 CFR Part 190 which would apply to real members of the public offsite and allow for credit to be taken in accounting for actual usage patterns such as occupancy time. The external dose factors provided on Table 5 were derived from Table E-2 of NUREG/CR-5512 (Reference 3).

Table 5

Dry Soil Maximum Concentration Values

Radionuclide	Soil Concentration pCi/kg (equal to 25 mrem/yr)
Cr-51	1.51E+05
Mn-54	5.50E+03
Fe-59	3.83E+03
Co-58	4.70E+03
Co-60	1.82E+03
Zn-65	7.85E+03
Zr-95	6.18E+03
Ag-110m	1.66E+03
Sb-124	2.51E+03
Cs-134	2.95E+03
Cs-137	8.13E+03
Ce-141	7.85E+04
Ce-144	8.75E+04

Assumptions include infinite planar distribution, uniform depth distribution to 15 cm, soil density at 1.625E+06 gm/m3 and external direct dose pathway only with a 100% occupancy factor.

3.2 Administrative Procedure Requirements:

Dry silt material shall be dispersed using typical agricultural dry bulk surface spreading practices only in approved disposal areas on site.

Complete records of each disposal will be maintained. These records will include the concentration of radionuclides detected in the silt, an estimate of the total volume of silt disposed of, the total radioactivity in each disposal operation as well as the total accumulated on each disposal plot at the time of the spreading, the plot on which the silt was applied, and the results of any dose calculations or maximum allowable accumulated activity determinations required to demonstrate that the dose limits imposed on these land spreading operations have not been exceeded. The determination of the total radioactivity and dose calculations shall also include all past septic waste and silt disposal operations that placed low level radioactive material on the designated disposal plots.

The periodic disposal of silt on each of the approved land spreading areas will be limited to within the same established dose and radioactivity criteria that have been approved for septic waste disposal.

Concentration limits that are applied to the disposal of earthen type materials (dry soil) shall restrict the placement of small volumes of material that have relatively high concentrations of radioactivity such that direct exposure could not exceed a small proportion (25%) of the annual dose limits to members of the public that is contained in 10 CFR Part 20.1301.

Any farmer leasing land used for the disposal of silt deposits will be notified of the applicable restrictions placed on the site due to the land spreading of low level contaminated material. These restrictions are the same as detailed for septic waste spreading as given in Reference 1.

4.0 EVALUATION OF ENVIRONMENTAL IMPACTS:

4.1 Site Characteristics

The designated disposal sites consist of two fields located on the Vermont Yankee Nuclear Power Plant site. Both fields are on the plant property within the site boundary security fence. Site A contains an approximate ten-acre parcel of land centered approximately 2,000 feet northwest of the Reactor Building. Site B consist of approximately two acres and is centered approximately 1,500 feet south of the Reactor Building. These are the same land parcels approved by the NRC for the land disposal of septic waste and are described in detail in Reference 1 along with the boundary restrictions for the placement of contaminated material.

Radiological assessments of septic waste disposal have determined that a single two-acre plot would be sufficient for the routine disposal of that waste stream over a 20-year period without exceeding the dose criteria to a maximum exposed individual or inadvertent intruder. As a result, the ten-acre field to the northwest can be divided into five disposal plots, with the two-acre site at the south end of the plant site providing a sixth plot. It is therefore concluded that there is sufficient space within the already approved disposal plots to accommodate additional material from the cooling tower basins along with the septic waste without the likelihood of exceeding the approved dose limit criteria.

Since the residual organic and inorganic solids associated with river sediment (silt) are similar to the sand and residual organic material remaining after decomposition of septic waste that is removed from the plant's septic tanks, the conclusions of no significant environmental (non-radiological) impact associated with the disposal of septic waste are not changed by the addition of another earthen type material, namely silt.

4.2 Radiological Impact:

The amount of cooling tower silt, in combination with any septic waste disposals, will be procedurally controlled to insure doses are maintained within the prior approved limits (Reference 1). These limits are based on

past NRC proposed guidance (described in AIF/NESP-037), August 1986). The dose criteria require that the maximally exposed member of the general public receive a dose less than 1 mrem/year to the whole body or any organ due to the disposed material and less than 5 mrem/year to the whole body or any organ of an inadvertent intruder.

To assess the doses received by the maximally exposed individual and inadvertent intruder resulting from silt spreading, the same pathway modeling, assumptions and dose calculation methods as approved for septic disposal are used. These dose models implement the methodologies and dose conversion factors as provided in Regulatory Guide 1.109 (Reference 2).

Six potential pathways have been identified and include:

(a) Standing on contaminated ground,
(b) Inhalation of resuspended radioactivity,
(c) Ingestion of leafy vegetables,
(d) Ingestion of stored vegetables,
(f) Ingestion of meat, and
(g) Ingestion of cow's milk

Based on the septic waste evaluations, the liquid pathway was determined to be insignificant.

Both the maximum individual and inadvertent intruder are assumed to be exposed to these pathways with the difference between them related to occupancy time. The basic assumptions used in the radiological analyses include:

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

(b) For the purpose of projecting and illustrating the magnitude of dose impacts over the remaining life of the plant, it is assumed that the current concentration levels of activity detected in silt remain

constant. Table 1 indicates the measured radioactivity levels for Cobalt-60 and Cesium-137 first noted in silt material.

(c) The maximum radiation source corresponds to the accumulation of radioactive material on a single plot (two acre) within the approved disposal sites over a period of 13 operating cycles. This extends over the next 18 years until after the operating license expires in 2012. The initial application (referenced to June 1995) consists of 14,000 cubic feet of silt collected in 1993 along with the first periodic clean out of the tower basins that adds an additional 4,000 cubic feet. All subsequent applications of 4,000 cubic feet occur at 18-month intervals.

(d) For the analysis of the radiological impact during the Vermont Yankee active control of the disposal sites, no plowing is assumed to take place and all dispersed radioactive material remains on the surface forming a source of unshielded direct radiation.

(e) No radioactive material is dispersed directly on crops for human or animal consumption. Crop contamination is only through root uptake.

(f) The deposition on crops of suspended radioactivity is insignificantly small.

(g) Pathway data and usage factors used in the analysis are the same as those used in the plant's ODCM assessment of off-site radiological impact from routine releases with the exception that the fraction of stored vegetables grown on the contaminated land was conservatively increased from 0.76 to 1.0 (at present no vegetable crops for human consumption are grown on any of the approved disposal plots).

(h) It is conservatively assumed that Vermont Yankee relinquishes control of the disposal sites after the operating license expires in 2012 (i.e., the source term accumulated on a single, 2-acre disposal plot applies also for the inadvertent intruder).

(i) For the analysis of the impact after Vermont Yankee control of the site is relinquished, the radioactive material is plowed under and forms a uniform mix with the top six inches of soil; but nonetheless, undergoes resuspension in air at the same rate as the unplowed surface contamination. For direct ground plane exposure the self shielding due to the six-inch plow layer reduces the surface dose rate by about a factor of four.

The dose models and methods used to generate deposition values and accumulated activity over the operating life of the plant are documented in Attachment 2 to Reference 1. Based on the measured concentrations and silt volumes noted in Section 2.0 above, the total radioactivity that remains on the disposal plots after the operating license expires is estimated on Table 6.

Table 6

Projected Radioactivity Buildup Due to Silt Spreading

Nuclide	Contribution from initial 14,000 ft3 (uCi)	Accumulation from 13 cycles at 4,000 ft3/ea. (uCi)	Total Remaining in year 2013 (uCi)
Cobalt-60	3.2	61.9	65.1
Cesium-137	104.9	500.5	605.4

The calculated potential radiation exposure following the spreading of all silt material anticipated to be generated through the remainder of the operating license on a single, two-acre plot is provided on Table 7.

Table 7

Dose Impact Due to Continued Spreading to End of License

Disposal Site Access	Radiation Exposure	Individual/Organ
Controlled by VYNPS (max. exposed individual)	0.228 mrem/yr 0.820 mrem/yr max.	adult/whole body child/bone
Uncontrolled by VYNPS (inadvertent intruder after license termination)	1.46 mrem/yr 2.41 mrem/yr max.	adult/whole body child/bone

The individual pathway contributions to the total dose due to continued silt spreading are shown on Table 8.

Table 8

Pathway-Dependent Critical Organ Doses

Pathway	Maximally exposed Individual/Organ (Child/Bone) (mrem/year)	Inadvertent Intruder Critical Individual/Organ (Child/Bone) (mrem/year)
Ground Irradiation	0.0474	0.957
Inhalation	0.00814	0.685
Stored Vegetables	0.528	0.528
Leafy Vegetables	0.0265	0.0265
Milk Ingestion	0.201	0.201
Meat Ingestion	0.00833	0.00833
Total:	0.82	2.41

In addition, the isotopic breakdown of the critical organ doses listed above (Table 8) for the two detected radionuclides is seen to be:

Table 9

Isotopic Breakdown of Maximum Radiation Exposures

Description	Isotope	Radioactivity (uCi/2 acres)	Dose (mrem/yr)	Percent of total
During control of disposal sites Max. organ: child/bone	Cs-137	605.4	0.805	98.2
	Co-60	65.1	0.0144	1.8
			0.82	
Termination of disposal site Max. organ: child/bone	Cs-137	605.4	2.12	88.0
	Co-60	65.1	0.29	12.0
			2.41	

For comparison to the total dose calculated assuming the continued disposal of silt removed from the tower basins through the end of the operating license, the dose from just the original 14,000 cubic feet collected is shown on Table 10.

Table 10

Dose Impact Due to Single (14,000 ft3) Silt Spreading

Disposal Site Access	Radiation Exposure	Individual/Organ
Controlled by VYNPS (max. exposed individual in 1995)	0.064 mrem/yr 0.219 mrem/yr max.	adult/whole body child/bone
Uncontrolled by VYNPS (inadvertent intruder after license termination)	0.224 mrem/yr 0.393 mrem/yr max.	adult/whole body child/bone

Table 10 shows that the application of the silt material initially collected (14,000 cubic feet) accounts for about 27 percent of the maximum individual organ dose during the control period as compared to the scenario of continued periodic silt spreading over the balance of the operating license. This illustrates that dose impacts from the material currently collected are well below the acceptance criteria of limiting the dose from any two-acre plot to no more than 1 mrem/year during the control period and 5 mrem/year after termination of the license, and is expected to remain below the acceptance criteria throughout the plant life. If unexpected buildup of radioactivity in future silt clean-out operations were to occur, the option for use of alternate disposal plots remains available to ensure that the impact from any single, two-acre plot stays within the acceptance criteria.

Also of interest are derived dose conversion factors which provide a means of ensuring that septic and silt disposal operations remain within the prescribed radiological guidelines noted above. The critical organ (worst case) and whole body dose factors for all pathways on a per acre bases are

given on Table 11 for periods during Vermont Yankee control of the disposal site and on Table 12 for post control periods associated with the inadvertent intruder scenario. The dose conversion factors have been expanded to include other potential radionuclide beyond the original five that were addressed in Reference 1. This provides a means to assess other nuclides if future disposal operations identify additional radionuclides not previously observed. The development of these additional nuclide dose conversion factors utilize the same modeling and pathway assumptions as used to derive the factors for the original five radionuclides identified in septic waste. The models for these site and pathway-specific dose factors are those in Regulatory Guide 1.109 (Reference 2) and are described in detail in Attachment II to Reference 1.

Table 11

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

Nuclide	Individual/Organ	Critical Organ Dose Factor (mrem/yr per uCi/acre)	Whole Body Dose Factor (mrem/yr per uCi/acre)
Cr-51	Teen/Lung	1.14E-05	5.76E-06
Mn-54	Adult/GI-LLI	3.75E-04	1.93E-04
Fe-55	Child/Bone	6.45E-06	1.06E-06
Fe-59	Teen/Lung	4.61E-04	2.13E-04
Co-58	Teen/Lung	3.27E-04	2.01E-04
Co-60	Teen/Lung	7.17E-04	5.31E-04
Zn-65	Child/Liver	1.64E-02	1.03E-02
Zr-95	Teen/Lung	4.47E-04	1.34E-04
Ag110m	Teen/GI-LLI	1.32E-02	5.24E-04
Sb-124	Teen/Lung	8.34E-04	3.54E-04
Cs-134	Child/Liver	3.18E-03	1.28E-03
Cs-137	Child/Bone	2.66E-03	7.02E-04
Ce-141	Teen/Lung	1.54E-04	1.50E-05
Ce-144	Teen/Lung	6.00E-04	2.44E-05

Table 12

All-Pathway Critical Organ / Whole Body Dose Conversion Factors
Post Vermont Yankee Control of Disposal Sites
(Inadvertent Intruder)

Nuclide	Individual/Organ	Critical Organ Dose Factor (mrem/yr per uCi/acre)	Whole Body Dose Factor (mrem/yr per uCi/acre)
Cr-51	Teen/Lung	5.89E-04	1.19E-04
Mn-54	Teen/Lung	1.02E-02	3.12E-03
Fe-55	Teen/Lung	3.50E-04	2.27E-05
Fe-59	Teen/Lung	2.55E-02	4.43E-03
Co-58	Teen/Lung	1.59E-02	3.72E-03
Co-60	Teen/Lung	3.19E-02	9.09E-03
Zn-65	Child/Liver	1.89E-02	1.25E-02
Zr-95	Teen/Lung	2.93E-02	2.99E-03
Ag110m	Teen/Lung	3.59E-02	9.53E-03
Sb-124	Teen/Lung	4.73E-02	7.04E-03
Cs-134	Child/Liver	1.21E-02	9.36E-03
Cs-137	Child/Bone	6.98E-03	3.85E-03
Ce-141	Teen/Lung	1.21E-02	3.44E-04
Ce-144	Teen/Lung	5.00E-02	1.52E-03

5.0 RADIATION PROTECTION:

The disposal operation of silt material from the cooling tower basins will follow the applicable Vermont Yankee procedures to maintain doses as low as reasonably achievable and within the specific dose criteria as previously approved for septic waste disposal (Reference 1).

6.0 CONCLUSIONS:

Silt collected from the cooling tower basins is an earthen type material that is similar in characteristics to septic waste residual solids with respect to the radiological pathway behavior and modeling and can be disposed of through on-site land spreading on the same disposal plots as previously evaluated and approved for septic waste disposal. The radiological assessment of low level contaminated silt shows that the projected dose from the on-site periodic spreading of this material will have no significant dose impact to members of the public and can be maintained below the approved dose limitations already in place for septic waste.

7.0 REFERENCES:

(1) Vermont Yankee ODCM, Appendix B; "Approval of Criteria for Disposal of Slightly Contaminated Septic Water On-Site at Vermont Yankee". (Included NRC approval letter dated August 30, 1989, VY request for approval dated June 28, 1989 with Attachments I and II).

(2) USNRC Regulatory Guide 1.109, Rev. 1; "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", dated October 1977.

(3) NUREG/CR-5512, Vol. 1, "Residual Radioactive Contamination From Decommissioning", Final Report, dated October 1992.

APPENDIX G

MAXIMUM PERMISSIBLE CONCENTRATIONS (MPCs) IN AIR AND WATER ABOVE NATURAL BACKGROUND TAKEN FROM 10CFR20.1 TO 20.602, APPENDIX B

APPENDIX G

With the implementation of the revised Part 20 to Title 10 of the Code of Federal Regulations (10CFR20.1001-20.2401), the Maximum Permissible Concentrations (MPCs) that were part of the old 10CFR20 were replaced by a new Appendix B to 10CFR20 for the limits that apply to effluents released to unrestricted areas. However, MPC values were also used and accepted as licensing conditions for the control of radioactive materials in situations other than those directly covered by the requirements of the regulations. One example is the on-site disposal of septic waste which used the MPC values as one criteria of acceptability for land spreading. Appendix B to the ODCM references 10CFR20.1-20.601 Appendix B MPCs as concentration criteria for this disposal option.

With the final publication of the revised 10CFR20.1001-20.2401, the original MPC tables of the old 10CFR20 are no longer in print. As such, this appendix to the ODCM is added to provide a reference source for the MPC values contained in the original Appendix B to 10CFR20.1-20.601 for those conditions that still refer to these requirements.

APPENDIX G

MAXIMUM PERMISSIBLE CONCENTRATIONS (MPCs)
(FROM 10CFR20.1 TO 20.602, APPENDIX B)

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Actinium (89)	Ac 227	S	$2x10^{-12}$	$6x10^{-5}$	$8x10^{-14}$	$2x10^{-6}$
		I	$3x10^{-11}$	$9x10^{-3}$	$9x10^{-13}$	$3x10^{-4}$
	Ac 228	S	$8x10^{-8}$	$3x10^{-3}$	$3x10^{-9}$	$9x10^{-5}$
		I	$2x10^{-8}$	$3x10^{-3}$	$6x10^{-10}$	$9x10^{-5}$
Americium (95)	Am 241	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Am 242m	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$3x10^{-10}$	$3x10^{-3}$	$9x10^{-12}$	$9x10^{-5}$
	Am 242	S	$4x10^{-8}$	$4x10^{-3}$	$1x10^{-9}$	$1x10^{-4}$
		I	$5x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
	Am 243	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Am 244	S	$4x10^{-6}$	$1x10^{-1}$	$1x10^{-7}$	$5x10^{-3}$
		I	$2x10^{-5}$	$1x10^{-1}$	$8x10^{-7}$	$5x10^{-3}$
Antimony	Sb 122	S	$2x10^{-7}$	$8x10^{-4}$	$6x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-7}$	$8x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
	Sb 124	S	$2x10^{-7}$	$7x10^{-4}$	$5x10^{-9}$	$2x10^{-5}$
		I	$2x10^{-8}$	$7x10^{-4}$	$7x10^{-10}$	$2x10^{-5}$
	Sb 125	S	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$3x10^{-8}$	$3x10^{-3}$	$9x10^{-10}$	$1x10^{-4}$
Argon (18)	A37	Sub[2]	$6x10^{-3}$	.....	$1x10^{-4}$	.....
	A41	Sub	$2x10^{-6}$	.....	$4x10^{-8}$	.....
Arsenic (33)	As 73	S	$2x10^{-6}$	$1x10^{-2}$	$7x10^{-8}$	$5x10^{-4}$
		I	$4x10^{-7}$	$1x10^{-2}$	$1x10^{-8}$	$5x10^{-4}$
	As 74	S	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$1x10^{-7}$	$2x10^{-3}$	$4x10^{-9}$	$5x10^{-5}$
	As 76	S	$1x10^{-7}$	$6x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
		I	$1x10^{-7}$	$6x10^{-4}$	$3x10^{-9}$	$2x10^{-5}$
	As 77	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$8x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$8x10^{-5}$

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Astatine (85)	At 211	S	$7x10^{-9}$	$5x10^{-5}$	$2x10^{-10}$	$2x10^{-6}$
		I	$3x10^{-8}$	$2x10^{-3}$	$1x10^{-9}$	$7x10^{-5}$
Barium (56)	Ba 131	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
	Ba 140	S	$1x10^{-7}$	$8x10^{-4}$	$4x10^{-9}$	$3x10^{-5}$
		I	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$2x10^{-5}$
Berkelium (97)	Bk 249	S	$9x10^{-10}$	$2x10^{-2}$	$3x10^{-11}$	$6x10^{-4}$
		I	$1x10^{-7}$	$2x10^{-2}$	$4x10^{-9}$	$6x10^{-4}$
	Bk 250	S	$1x10^{-7}$	$6x10^{-3}$	$5x10^{-9}$	$2x10^{-4}$
		I	$1x10^{-6}$	$6x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
Beryllium (4)	Be 7	S	$6x10^{-6}$	$5x10^{-2}$	$2x10^{-7}$	$2x10^{-3}$
		I	$1x10^{-6}$	$5x10^{-2}$	$4x10^{-8}$	$2x10^{-3}$
Bismuth (83)	Bi 206	S	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
		I	$1x10^{-7}$	$1x10^{-3}$	$5x10^{-9}$	$4x10^{-5}$
	Bi 207	S	$2x10^{-7}$	$2x10^{-3}$	$6x10^{-9}$	$6x10^{-5}$
		I	$1x10^{-8}$	$2x10^{-3}$	$5x10^{-10}$	$6x10^{-5}$
	Bi 210	S	$6x10^{-9}$	$1x10^{-3}$	$2x10^{-10}$	$4x10^{-5}$
		I	$6x10^{-9}$	$1x10^{-3}$	$2x10^{-10}$	$4x10^{-5}$
	Bi 212	S	$1x10^{-7}$	$1x10^{-2}$	$3x10^{-9}$	$4x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-2}$	$7x10^{-9}$	$4x10^{-4}$
Bromine (35)	Br 82	S	$1x10^{-6}$	$8x10^{-3}$	$4x10^{-8}$	$3x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
Cadmium (48)	Cd 109	S	$5x10^{-8}$	$5x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$
		I	$7x10^{-8}$	$5x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Cd 115m	S	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$3x10^{-5}$
		I	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$3x10^{-5}$
	Cd 115	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$3x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
Calcium (20)	Ca 45	S	$3x10^{-8}$	$3x10^{-4}$	$1x10^{-9}$	$9x10^{-6}$
		I	$1x10^{-7}$	$5x10^{-3}$	$4x10^{-9}$	$2x10^{-4}$
	Ca 47	S	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$5x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$3x10^{-5}$

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Californium (98)	Cf 249	S	$2x10^{-12}$	$1x10^{-4}$	$5x10^{-14}$	$4x10^{-6}$
		I	$1x10^{-10}$	$7x10^{-4}$	$3x10^{-12}$	$2x10^{-5}$
	Cf 250	S	$5x10^{-12}$	$4x10^{-4}$	$2x10^{-13}$	$1x10^{-5}$
		I	$1x10^{-10}$	$7x10^{-4}$	$3x10^{-12}$	$3x10^{-5}$
	Cf 251	S	$2x10^{-12}$	$1x10^{-4}$	$6x10^{-14}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$3x10^{-12}$	$3x10^{-5}$
	Cf 252	S	$6x10^{-12}$	$2x10^{-4}$	$2x10^{-13}$	$7x10^{-6}$
		I	$3x10^{-11}$	$2x10^{-4}$	$1x10^{-12}$	$7x10^{-6}$
	Cf 253	S	$8x10^{-10}$	$4x10^{-3}$	$3x10^{-11}$	$1x10^{-4}$
		I	$8x10^{-10}$	$4x10^{-3}$	$3x10^{-11}$	$1x10^{-4}$
	Cf 254	S	$5x10^{-12}$	$4x10^{-6}$	$2x10^{-13}$	$1x10^{-7}$
		I	$5x10^{-12}$	$4x10^{-6}$	$2x10^{-13}$	$1x10^{-7}$
Carbon (6)	C 14 (CO_2)	S	$4x10^{-6}$	$2x10^{-2}$	$1x10^{-7}$	$8x10^{-4}$
		Sub	$5x10^{-5}$	.....	$1x10^{-6}$	.....
Cerium (58)	Ce 141	S	$4x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$9x10^{-5}$
		I	$2x10^{-7}$	$3x10^{-3}$	$5x10^{-9}$	$9x10^{-5}$
	Ce 143	S	$3x10^{-7}$	$1x10^{-3}$	$9x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$4x10^{-5}$
	Ce 144	S	$1x10^{-8}$	$3x10^{-4}$	$3x10^{-10}$	$1x10^{-5}$
		I	$6x10^{-9}$	$3x10^{-4}$	$2x10^{-10}$	$1x10^{-5}$
Cesium (55)	Cs 131	S	$1x10^{-5}$	$7x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
		I	$3x10^{-6}$	$3x10^{-2}$	$1x10^{-7}$	$9x10^{-4}$
	Cs 134m	S	$4x10^{-5}$	$2x10^{-1}$	$1x10^{-6}$	$6x10^{-3}$
		I	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
	Cs 134	S	$4x10^{-8}$	$3x10^{-4}$	$1x10^{-9}$	$9x10^{-6}$
		I	$1x10^{-8}$	$1x10^{-3}$	$4x10^{-10}$	$4x10^{-5}$
	Cs 135	S	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$9x10^{-8}$	$7x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Cs 136	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
		I	$2x10^{-7}$	$2x10^{-3}$	$6x10^{-9}$	$6x10^{-5}$
	Cs 137	S	$6x10^{-8}$	$4x10^{-4}$	$2x10^{-9}$	$2x10^{-5}$
		I	$1x10^{-8}$	$1x10^{-3}$	$5x10^{-10}$	$4x10^{-5}$

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Dysprorium (66)	Dy 165	S	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$4x10^{-4}$
		I	$2x10^{-6}$	$1x10^{-2}$	$7x10^{-8}$	$4x10^{-4}$
	Dy 166	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$4x10^{-5}$
Einsteinium (99)	Es 253	S	$8x10^{-10}$	$7x10^{-4}$	$3x10^{-11}$	$2x10^{-5}$
		I	$6x10^{-10}$	$7x10^{-4}$	$2x10^{-11}$	$2x10^{-5}$
	Es 254m	S	$5x10^{-9}$	$5x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
		I	$6x10^{-9}$	$5x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
	Es 254	S	$2x10^{-11}$	$4x10^{-4}$	$6x10^{-13}$	$1x10^{-5}$
		I	$1x10^{-10}$	$4x10^{-4}$	$4x10^{-12}$	$1x10^{-5}$
	Es 255	S	$5x10^{-10}$	$8x10^{-4}$	$2x10^{-11}$	$3x10^{-5}$
		I	$4x10^{-10}$	$8x10^{-4}$	$1x10^{-11}$	$3x10^{-5}$
Erbium (68)	Er 169	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$9x10^{-5}$
		I	$4x10^{-7}$	$3x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
	Er 171	S	$7x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Europium (63)	Eu 152 (T/2=9.2 hrs)	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
	Eu 152 (T/2=13 yrs)	S	$1x10^{-8}$	$2x10^{-3}$	$4x10^{-10}$	$8x10^{-5}$
		I	$2x10^{-8}$	$2x10^{-3}$	$6x10^{-10}$	$8x10^{-5}$
	Eu 154	S	$4x10^{-9}$	$6x10^{-4}$	$1x10^{-10}$	$2x10^{-5}$
		I	$7x10^{-9}$	$6x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
	Eu 155	S	$9x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
		I	$7x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
Fermium (100)	Fm 254	S	$6x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
		I	$7x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
	Fm 255	S	$2x10^{-8}$	$1x10^{-3}$	$6x10^{-10}$	$3x10^{-5}$
		I	$1x10^{-8}$	$1x10^{-3}$	$4x10^{-10}$	$3x10^{-5}$
	Fm 256	S	$3x10^{-9}$	$3x10^{-5}$	$1x10^{-10}$	$9x10^{-7}$
		I	$2x10^{-9}$	$3x10^{-5}$	$6x10^{-11}$	$9x10^{-7}$
Fluorine (9)	F 18	S	$5x10^{-6}$	$2x10^{-2}$	$2x10^{-7}$	$8x10^{-4}$
		I	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$5x10^{-4}$

APPENDIX B TO §§20.1 - 20.602
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Gadolinium (64)	Gd 153	S	$2x10^{-7}$	$6x10^{-3}$	$8x10^{-9}$	$2x10^{-4}$
		I	$9x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Gd 159	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$8x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$8x10^{-5}$
Gallium (31)	Ga 72	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
Germanium (32)	Ge 71	S	$1x10^{-5}$	$5x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
		I	$6x10^{-6}$	$5x10^{-2}$	$2x10^{-7}$	$2x10^{-3}$
Gold (79)	Au 196	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$6x10^{-7}$	$4x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
	Au 198	S	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$5x10^{-5}$
	Au 199	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
Hafnium (72)	Hf 181	S	$4x10^{-8}$	$2x10^{-3}$	$1x10^{-9}$	$7x10^{-5}$
		I	$7x10^{-8}$	$2x10^{-3}$	$3x10^{-9}$	$7x10^{-5}$
Holmium (67)	Ho 166	S	$2x10^{-7}$	$9x10^{-4}$	$7x10^{-9}$	$3x10^{-5}$
		I	$2x10^{-7}$	$9x10^{-4}$	$6x10^{-9}$	$3x10^{-5}$
Hydrogen (1)	H3	S	$5x10^{-6}$	$1x10^{-1}$	$2x10^{-7}$	$3x10^{-3}$
		I	$5x10^{-6}$	$1x10^{-1}$	$2x10^{-7}$	$3x10^{-3}$
		Sub	$2x10^{-3}$	.....	$4x10^{-5}$	.....
Indium (49)	In 113m	S	$8x10^{-6}$	$4x10^{-2}$	$3x10^{-7}$	$1x10^{-3}$
		I	$7x10^{-6}$	$4x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
	In 114m	S	$1x10^{-7}$	$5x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
		I	$2x10^{-8}$	$5x10^{-4}$	$7x10^{-10}$	$2x10^{-5}$
	In 115m	S	$2x10^{-6}$	$1x10^{-2}$	$8x10^{-8}$	$4x10^{-4}$
		I	$2x20^{-6}$	$1x10^{-2}$	$6x10^{-8}$	$4x10^{-4}$
	In 115	S	$2x20^{-7}$	$3x10^{-3}$	$9x10^{-9}$	$9x10^{-5}$
		I	$3x20^{-8}$	$3x10^{-3}$	$1x10^{-9}$	$9x10^{-5}$
Iodine (53)	I 125	S	$5x30^{-9}$	$4x10^{-5}$	$8x10^{-11}$	$2x10^{-7}$
		I	$2x50^{-7}$	$6x10^{-3}$	$6x10^{-9}$	$2x10^{-4}$
	I 126	S	$8x20^{-9}$	$5x10^{-5}$	$9x10^{-11}$	$3x10^{-7}$
		I	$3x80^{-7}$	$3x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
	I 129	S	$2x30^{-9}$	$1x10^{-5}$	$2x10^{-11}$	$6x10^{-8}$
		I	$7x20^{-8}$	$6x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$

Revision 21 Date 08/14/97

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[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Iodine (53) . . . . . (Continued)	I 131	S I	$9x70^{-9}$ $3x90^{-7}$	$6x10^{-5}$ $2x10^{-3}$	$1x10^{-10}$ $1x10^{-8}$	$3x10^{-7}$ $6x10^{-5}$
	I 132	S I	$2x10^{-7}$ $9x10^{-7}$	$2x10^{-3}$ $5x10^{-3}$	$3x10^{-9}$ $3x10^{-8}$	$8x10^{-6}$ $2x10^{-4}$
	I 133	S I	$3x10^{-8}$ $2x10^{-7}$	$2x10^{-4}$ $1x10^{-3}$	$4x10^{-10}$ $7x10^{-9}$	$1x10^{-6}$ $4x10^{-5}$
	I 134	S I	$5x10^{-7}$ $3x10^{-6}$	$4x10^{-3}$ $2x10^{-2}$	$6x10^{-9}$ $1x10^{-7}$	$2x10^{-5}$ $6x10^{-4}$
	I 135	S I	$1x10^{-7}$ $4x10^{-7}$	$7x10^{-4}$ $2x10^{-3}$	$1x10^{-9}$ $1x10^{-8}$	$4x10^{-6}$ $7x10^{-5}$
Iridium (77)	Ir 190	S I	$1x10^{-6}$ $4x10^{-7}$	$6x10^{-3}$ $5x10^{-3}$	$4x10^{-8}$ $1x10^{-8}$	$2x10^{-4}$ $2x10^{-4}$
	Ir 192	S I	$1x10^{-7}$ $3x10^{-8}$	$1x10^{-3}$ $1x10^{-3}$	$4x10^{-9}$ $9x10^{-10}$	$4x10^{-5}$ $4x10^{-5}$
	Ir 194	S I	$2x10^{-7}$ $2x10^{-7}$	$1x10^{-3}$ $9x10^{-4}$	$8x10^{-9}$ $5x10^{-9}$	$3x10^{-5}$ $3x10^{-5}$
Iron (26)	Fe 55	S I	$9x10^{-7}$ $1x10^{-6}$	$2x10^{-2}$ $7x10^{-2}$	$3x10^{-8}$ $3x10^{-8}$	$8x10^{-4}$ $2x10^{-3}$
	Fe 59	S I	$1x10^{-7}$ $5x10^{-8}$	$2x10^{-3}$ $2x10^{-3}$	$5x10^{-9}$ $2x10^{-9}$	$6x10^{-5}$ $5x10^{-5}$
Krypton (36)	Kr 85m	Sub	$6x10^{-6}$	.....	$1x10^{-7}$	.....
	Kr 85	Sub	$1x10^{-5}$	.....	$3x10^{-7}$	.....
	Kr 87	Sub	$1x10^{-6}$	.....	$2x10^{-8}$	.....
	Kr 88	Sub	$1x10^{-6}$	.....	$2x10^{-8}$	.....
Lanthanum (57)	La 140	S I	$2x10^{-7}$ $1x10^{-7}$	$7x10^{-4}$ $7x10^{-4}$	$5x10^{-9}$ $4x10^{-9}$	$2x10^{-5}$ $2x10^{-5}$
Lead (82)	Pb 203	S I	$3x10^{-6}$ $2x10^{-6}$	$1x10^{-2}$ $1x10^{-2}$	$9x10^{-8}$ $6x10^{-8}$	$4x10^{-4}$ $4x10^{-4}$
	Pb 210	S I	$1x10^{-10}$ $2x10^{-10}$	$4x10^{-6}$ $5x10^{-3}$	$4x10^{-12}$ $8x10^{-12}$	$1x10^{-7}$ $2x10^{-4}$
	Pb 212	S I	$2x10^{-8}$ $2x10^{-8}$	$6x10^{-4}$ $5x10^{-4}$	$6x10^{-10}$ $7x10^{-10}$	$2x10^{-5}$ $2x10^{-5}$

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Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Lutetium (71)	Lu 177	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Manganese (25)	Mn 52	S	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-7}$	$9x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
	Mn 54	S	$4x10^{-7}$	$4x10^{-3}$	$1x10^{-8}$	$1x10^{-4}$
		I	$4x10^{-8}$	$3x10^{-3}$	$1x10^{-9}$	$1x10^{-4}$
	Mn 56	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Mercury (80)	Hg 197m	S	$7x10^{-7}$	$6x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
		I	$8x10^{-7}$	$5x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
	Hg 197	S	$1x10^{-6}$	$9x10^{-3}$	$4x10^{-8}$	$3x10^{-4}$
		I	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$5x10^{-4}$
	Hg 203	S	$7x10^{-8}$	$5x10^{-4}$	$2x10^{-9}$	$2x10^{-5}$
		I	$1x10^{-7}$	$3x10^{-3}$	$4x10^{-9}$	$1x10^{-4}$
Molybdenum (42)	Mo 99	S	$7x10^{-7}$	$5x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$4x10^{-5}$
Neodymium (60)	Nd 144	S	$8x10^{-11}$	$2x10^{-3}$	$3x10^{-12}$	$7x10^{-5}$
		I	$3x10^{-10}$	$2x10^{-3}$	$1x10^{-11}$	$8x10^{-5}$
	Nd 147	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
		I	$2x10^{-7}$	$2x10^{-3}$	$8x10^{-9}$	$6x10^{-5}$
	Nd 149	S	$2x10^{-6}$	$8x10^{-3}$	$6x10^{-8}$	$3x10^{-4}$
		I	$1x10^{-6}$	$8x10^{-3}$	$5x10^{-8}$	$3x10^{-4}$
Neptunium (93)	Np 237	S	$4x10^{-12}$	$9x10^{-5}$	$1x10^{-13}$	$3x10^{-6}$
		I	$1x10^{-10}$	$9x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Np 239	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$7x10^{-7}$	$4x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Nickel (28)	Ni 59	S	$5x10^{-7}$	$6x10^{-3}$	$2x10^{-8}$	$2x10^{-4}$
		I	$8x10^{-7}$	$6x10^{-2}$	$3x10^{-8}$	$2x10^{-3}$
	Ni 63	S	$6x10^{-8}$	$8x10^{-4}$	$2x10^{-9}$	$3x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-2}$	$1x10^{-8}$	$7x10^{-4}$
	Ni 65	S	$9x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$

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Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Niobium (Columbium) (41)	Nb 93m	S	$1x10^{-7}$	$1x10^{-2}$	$4x10^{-9}$	$4x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-2}$	$5x10^{-9}$	$4x10^{-4}$
	Nb 95	S	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$1x10^{-7}$	$3x10^{-3}$	$3x10^{-9}$	$1x10^{-4}$
	Nb 97	S	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
Osmium (76)	Os 185	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$7x10^{-5}$
		I	$5x10^{-8}$	$2x10^{-3}$	$2x10^{-9}$	$7x10^{-5}$
	Os 191m	S	$2x10^{-5}$	$7x10^{-2}$	$6x10^{-7}$	$3x10^{-3}$
		I	$9x10^{-6}$	$7x10^{-2}$	$3x10^{-7}$	$2x10^{-3}$
	Os 191	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
	Os 193	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-3}$	$9x10^{-9}$	$5x10^{-5}$
Palladium (46)	Pd 103	S	$1x10^{-6}$	$1x10^{-2}$	$5x10^{-8}$	$3x10^{-4}$
		I	$7x10^{-7}$	$8x10^{-3}$	$3x10^{-8}$	$3x10^{-4}$
	Pd 109	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$9x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$7x10^{-5}$
Phosphorus (15)	P 32	S	$7x10^{-8}$	$5x10^{-4}$	$2x10^{-9}$	$2x10^{-5}$
		I	$8x10^{-8}$	$7x10^{-4}$	$3x10^{-9}$	$2x10^{-5}$
Platinum (78)	Pt 191	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
	Pt 193m	S	$7x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
	Pt 193	S	$1x10^{-6}$	$3x10^{-2}$	$4x10^{-8}$	$9x10^{-4}$
		I	$3x10^{-7}$	$5x10^{-2}$	$1x10^{-8}$	$2x10^{-3}$
	Pt 197m	S	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
	Pt 197	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$

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Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Plutonium (94)	Pu 238	S I	$2x10^{-12}$ $3x10^{-11}$	$1x10^{-4}$ $8x10^{-4}$	$7x10^{-14}$ $1x10^{-12}$	$5x10^{-6}$ $3x10^{-5}$
	Pu 239	S I	$2x10^{-12}$ $4x10^{-11}$	$1x10^{-4}$ $8x10^{-4}$	$6x10^{-14}$ $1x10^{-12}$	$5x10^{-6}$ $3x10^{-5}$
	Pu 240	S I	$2x10^{-12}$ $4x10^{-11}$	$1x10^{-4}$ $8x10^{-4}$	$6x10^{-14}$ $1x10^{-12}$	$5x10^{-6}$ $3x10^{-5}$
	Pu 241	S I	$9x10^{-11}$ $4x10^{-8}$	$7x10^{-3}$ $4x10^{-2}$	$3x10^{-12}$ $1x10^{-9}$	$2x10^{-4}$ $1x10^{-3}$
	Pu 242	S I	$2x10^{-12}$ $4x10^{-11}$	$1x10^{-4}$ $9x10^{-4}$	$6x10^{-14}$ $1x10^{-12}$	$5x10^{-6}$ $3x10^{-5}$
	Pu 243	S I	$2x10^{-6}$ $2x10^{-6}$	$1x10^{-2}$ $1x10^{-2}$	$6x10^{-8}$ $8x10^{-8}$	$3x10^{-4}$ $3x10^{-4}$
	Pu 244	S I	$2x10^{-12}$ $3x10^{-11}$	$1x10^{-4}$ $3x10^{-4}$	$6x10^{-14}$ $1x10^{-12}$	$4x10^{-6}$ $1x10^{-5}$
Polonium (84)	Po 210	S I	$5x10^{-10}$ $2x10^{-10}$	$2x10^{-5}$ $8x10^{-4}$	$2x10^{-11}$ $7x10^{-12}$	$7x10^{-7}$ $3x10^{-5}$
Potassium (19)	K42	S I	$2x10^{-6}$ $1x10^{-7}$	$9x10^{-3}$ $6x10^{-4}$	$7x10^{-8}$ $4x10^{-9}$	$3x10^{-4}$ $2x10^{-5}$
Praseodymium (59)	Pr 142	S I	$2x10^{-7}$ $2x10^{-7}$	$9x10^{-4}$ $9x10^{-4}$	$7x10^{-9}$ $5x10^{-9}$	$3x10^{-5}$ $3x10^{-5}$
	Pr 143	S I	$3x10^{-7}$ $2x10^{-7}$	$1x10^{-3}$ $1x10^{-3}$	$1x10^{-8}$ $6x10^{-9}$	$5x10^{-5}$ $5x10^{-5}$
Promethium (61)	Pm 147	S I	$6x10^{-8}$ $1x10^{-7}$	$6x10^{-3}$ $6x10^{-3}$	$2x10^{-9}$ $3x10^{-9}$	$2x10^{-4}$ $2x10^{-4}$
	Pm 149	S I	$3x10^{-7}$ $2x10^{-7}$	$1x10^{-3}$ $1x10^{-3}$	$1x10^{-8}$ $8x10^{-9}$	$4x10^{-5}$ $4x10^{-5}$
Protoactinium (91) . . .	Pa 230	S I	$2x10^{-9}$ $8x10^{-10}$	$7x10^{-3}$ $7x10^{-3}$	$6x10^{-11}$ $3x10^{-11}$	$2x10^{-4}$ $2x10^{-4}$
	Pa 231	S I	$1x10^{-12}$ $1x10^{-10}$	$3x10^{-5}$ $8x10^{-4}$	$4x10^{-14}$ $4x10^{-12}$	$9x10^{-7}$ $2x10^{-5}$
	Pa 233	S I	$6x10^{-7}$ $2x10^{-7}$	$4x10^{-3}$ $3x10^{-3}$	$2x10^{-8}$ $6x10^{-9}$	$1x10^{-4}$ $1x10^{-4}$

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[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	.....	1×10^{-8}	.....
	Rn 222[3]		3×10^{-8}	.....	3×10^{-9}	.....
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}

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Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}

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[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Strontium (38) . . . . . (Continued)	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}

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Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thalium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th 227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
		I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th 231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th 232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
		I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th natural	S	6×10^{-11}	6×10^{-5}	2×10^{-12}	2×10^{-6}
		I	6×10^{-11}	6×10^{-4}	2×10^{-12}	2×10^{-5}
	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}

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[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
Tungsten (Wolfram) (74) .	W 181	S I	$2x10^{-6}$ $1x10^{-7}$	$1x10^{-2}$ $1x10^{-2}$	$8x10^{-8}$ $4x10^{-9}$	$4x10^{-4}$ $3x10^{-4}$
	W 185	S I	$8x10^{-7}$ $1x10^{-7}$	$4x10^{-3}$ $3x10^{-3}$	$3x10^{-8}$ $4x10^{-9}$	$1x10^{-4}$ $1x10^{-4}$
	W 187	S I	$4x10^{-7}$ $3x10^{-7}$	$2x10^{-3}$ $2x10^{-3}$	$2x10^{-8}$ $1x10^{-8}$	$7x10^{-5}$ $6x10^{-5}$
Uranium (92)	U 230	S I	$3x10^{-10}$ $1x10^{-10}$	$1x10^{-4}$ $1x10^{-4}$	$1x10^{-11}$ $4x10^{-12}$	$5x10^{-6}$ $5x10^{-6}$
	U 232	S I	$1x10^{-10}$ $3x10^{-11}$	$8x10^{-4}$ $8x10^{-4}$	$3x10^{-12}$ $9x10^{-13}$	$3x10^{-5}$ $3x10^{-5}$
	U 233	S I	$5x10^{-10}$ $1x10^{-10}$	$9x10^{-4}$ $9x10^{-4}$	$2x10^{-11}$ $4x10^{-12}$	$3x10^{-5}$ $3x10^{-5}$
	U 234	S[4] I	$6x10^{-10}$ $1x10^{-10}$	$9x10^{-4}$ $9x10^{-4}$	$2x10^{-11}$ $4x10^{-12}$	$3x10^{-5}$ $3x10^{-5}$
	U 235	S[4] I	$5x10^{-10}$ $1x10^{-10}$	$8x10^{-4}$ $8x10^{-4}$	$2x10^{-11}$ $4x10^{-12}$	$3x10^{-5}$ $3x10^{-5}$
	U 236	S I	$6x10^{-10}$ $1x10^{-10}$	$1x10^{-3}$ $1x10^{-3}$	$2x10^{-11}$ $4x10^{-12}$	$3x10^{-5}$ $3x10^{-5}$
	U 238	S[4] I	$7x10^{-11}$ $1x10^{-10}$	$1x10^{-3}$ $1x10^{-3}$	$3x10^{-12}$ $5x10^{-12}$	$4x10^{-5}$ $4x10^{-5}$
	U 240	S I	$2x10^{-7}$ $2x10^{-7}$	$1x10^{-3}$ $1x10^{-3}$	$8x10^{-9}$ $6x10^{-9}$	$3x10^{-5}$ $3x10^{-5}$
	U-natural	S[4] I	$1x10^{-10}$ $1x10^{-10}$	$1x10^{-3}$ $1x10^{-3}$	$5x10^{-12}$ $5x10^{-12}$	$3x10^{-5}$ $3x10^{-5}$
Vanadium (23)	V 48	S I	$2x10^{-7}$ $6x10^{-8}$	$9x10^{-4}$ $8x10^{-4}$	$6x10^{-9}$ $2x10^{-9}$	$3x10^{-5}$ $3x10^{-5}$
Xenon (54)	Xe 131m	Sub	$2x10^{-5}$	.....	$4x10^{-7}$	.....
	Xe 133	Sub	$1x10^{-5}$	.....	$3x10^{-7}$	.....
	Xe 133m	Sub	$1x10^{-5}$	.....	$3x10^{-7}$	.....
	Xe 135	Sub	$4x10^{-6}$	.....	$1x10^{-7}$	.....
Ytterbium (70)	Yb 175	S I	$7x10^{-7}$ $6x10^{-7}$	$3x10^{-3}$ $3x10^{-3}$	$2x10^{-8}$ $2x10^{-8}$	$1x10^{-4}$ $1x10^{-4}$
Yttrium (39)	Y 90	S I	$1x10^{-7}$ $1x10^{-7}$	$6x10^{-4}$ $6x10^{-4}$	$4x10^{-9}$ $3x10^{-9}$	$2x10^{-5}$ $2x10^{-5}$

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[See footnotes at end of Appendix B]

Element (atomic number)	Isotope[1]		Table I		Table II	
			Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.	.....	Sub	1×10^{-6}	.....	3×10^{-8}	.....
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.	.....		3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above which decays by alpha emission or spontaneous fission.	.....		6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

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[1]Soluble (S); Insoluble (I).

[2]"Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

[3]These radon concentrations are appropriate for protection from radon-222 combined with its short-lived daughters. Alternatively, the value in Table I may be replaced by one-third (1/3) "working level." (A "working level" is defined as any combination of short-lived radon-222 daughters, polonium-218, lead-214, bismuth-214 and polonium-214, in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of 1.3×10^5 MeV of alpha particle energy.) The Table II value may be replaced by one-thirtieth (1/30) of a "working level." The limit on radon-222 concentrations in restricted areas may be based on an annual average.

[4]For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If the percent by weight-enrichment of U-235 is less than 5, the concentration value for a 40-hour work week, Table I, is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour work week shall not exceed 8×10^{-3} SA μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The concentration value for Table II is 0.007 milligrams uranium per cubic meter of air. The specific activity for natural uranium is 6.77×10^{-7} curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:

$SA = 3.6 \times 10^{-7}$ curies/gram U U-depleted

$SA = (0.4 + 0.38\ E + 0.0034\ E^2)\ 10^{-6}$ $E \geq 0.72$

where E is the percentage by weight of U-235, expressed as percent.

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$(C_A/MPC_A) + (C_B/MPC_B) + (C_C/MPC_C) \leq 1$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

a. For purposes of Table I, Col. 1 - 6×10^{-13}

b. For purposes of Table I, Col. 2 - 4×10^{-7}

c. For purposes of Table II, Col. 1 - 2×10^{-14}

d. For purposes of Table II, Col. 2 - 3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B for any radionuclide which is not known to be absent from the mixture; or

c. Element (atomic number) and isotope	Table I		Table II	
	Col. 1 Air ([PT1]µCi/ml)	Col. 2 Water (µCi/ml)	Col. 1 Air (µCi/ml)	Col. 2 Water (µCi/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131 (I 133, Table II only), Pb 210, Po 210, At 211, Ra 23, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	.....	$9x10^{-5}$	.....	$3x10^{-6}$
If it is known that Sr 90, I 125, I 126, I 129 (I 131, I 133, Table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	.....	$6x10^{-5}$	.....	$2x10^{-6}$
If it is known that Sr 90, I 129 (I 125, I 126, I 131, Table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	.....	$2x10^{-5}$	.....	$6x10^{-7}$
If it is known that (I 129, Table II only), Ra 226, and Ra 228 are not present . .	.....	$3x10^{-6}$	.....	$1x10^{-7}$
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	$3x10^{-9}$	.....	$1x10^{-10}$	.....
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	$3x10^{-10}$	.....	$1x10^{-11}$	.....
If it is known that alpha-emitters and Ac 227 are not present	$3x10^{-11}$	.....	$1x10^{-12}$	.....
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 251 are not present	$3x10^{-12}$	.....	$1x10^{-13}$	.....

4. If a mixture of radionuclides consists of uranium and its daughters in ore dust prior to chemical separation of the uranium from the ore, the values specified below may be used for uranium and its daughters through radium-266, instead of those from paragraphs 1, 2, or 3 above.

a. For purposes of Table I, Col. 1 - $1x10^{-10}$ µCi/ml gross alpha activity; or $5x10^{-11}$ µCi/ml natural uranium or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1 - $3x10^{-12}$ µCi/ml gross alpha activity; $2x10^{-12}$ µCi/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix "B" (MPC_A) does not exceed 1/10, (i.e. $C_A/MPC_A \leq 1/10$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4 i.e.

($C_A/MPC_A + C_B/MPC_B \ldots + \leq 1/4$).