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Point Beach Nuclear Plant
Operated by Nuclear Management Company, LLC

April 29, 2004

NRC 2004-0045
10 CFR 50.36a

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266 and 50-301
License Nos. DPR-24 and DPR-27

Annual Monitoring Report - 2003

Enclosed is the Annual Monitoring Report for Point Beach Nuclear Plant (PBNP), Units 1 and 2, for the period January 1 through December 31, 2003. This report is submitted in accordance with 10 CFR 50.36a and PBNP Technical Specifications 5.6.2.

The Annual Monitoring Report contains information regarding plant releases, solid waste shipments, results from the radiological environmental monitoring program, as well as miscellaneous reportable items from this reporting period. This report also covers the results of the radiological monitoring of the PBNP Independent Spent Fuel Storage Installation (ISFSI) as allowed by 10 CFR 72.44.

The Environmental Manual (EM), Offsite Dose Calculation Manual (ODCM), and the Radiological Effluent Control Manual (RECM) were revised in 2003; therefore, a copy of each manual is also enclosed.

This letter contains no new commitments and no revisions to existing commitments.

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Site Vice-President, Point Beach Nuclear Plant
Nuclear Management Company, LLC

Enclosures:
1 – Annual Monitoring Report
2 – Environmental Manual
3 – Offsite Dose Calculation Manual
4 – Radiological Effluent Control Manual

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American Nuclear Insurers
WI Division of Public Health, Radiation Protection Section

ENCLOSURES

1 – ANNUAL MONITORING REPORT

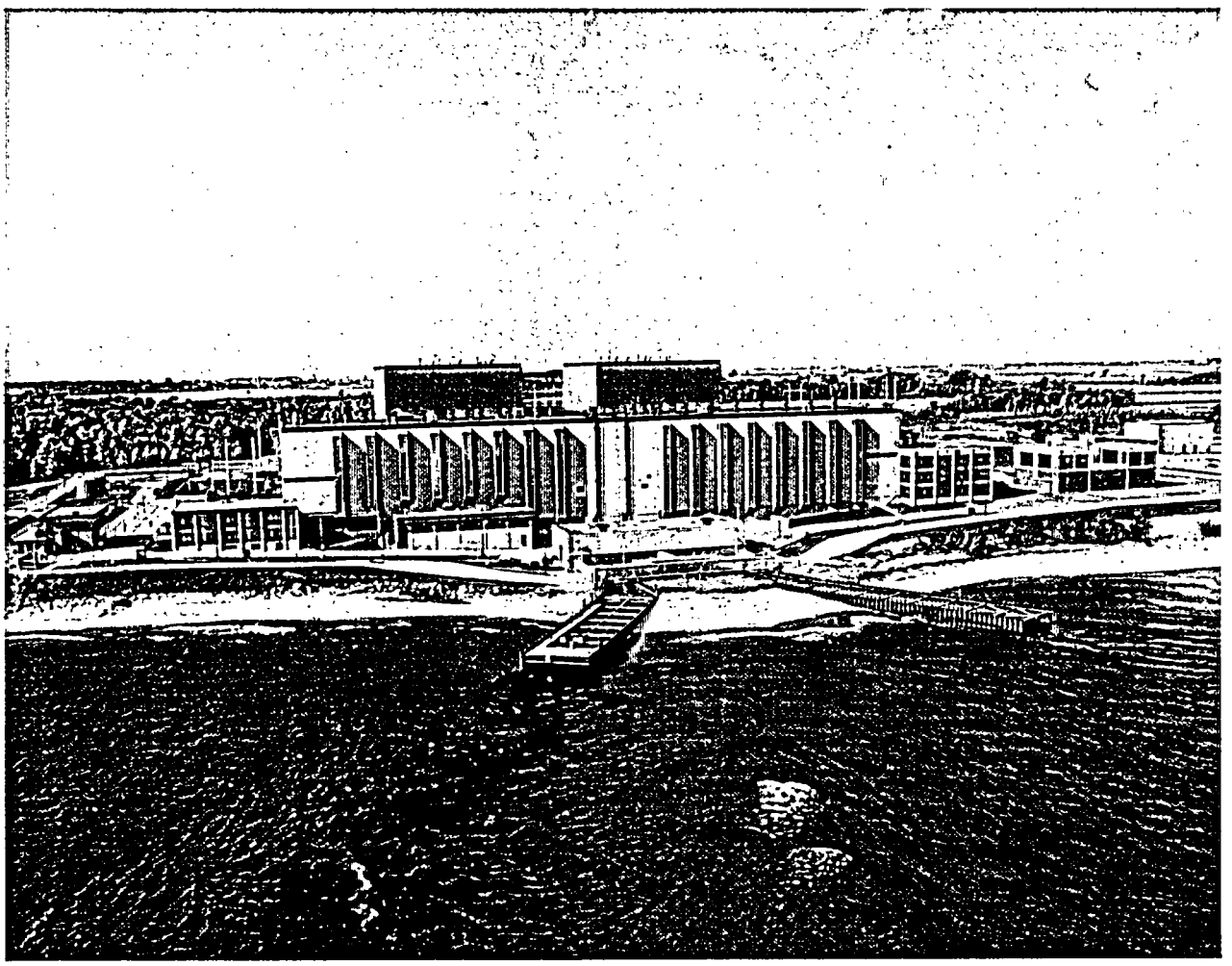
2 – ENVIRONMENTAL MANUAL

3 – OFFSITE DOSE CALCULATION MANUAL

4 – RADIOLOGICAL EFFLUENT CONTROL MANUAL

ANNUAL MONITORING REPORT 2003

NUCLEAR MANAGEMENT COMPANY, LLC
POINT BEACH NUCLEAR PLANT



January 1, 2003, through December 31, 2003
April 2004

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EXECUTIVE SUMMARY

This Annual Monitoring Report for the period of January 1, 2003, through December 31, 2003, is submitted in accordance with Point Beach Nuclear Plant (PBNP) Units 1 and 2 Technical Specification 5.6.2 and filed under Dockets 50-266 and 50-301 for Facility Operating Licenses DPR-24 and DPR-27, respectively. The report presents the results of effluent and environmental monitoring programs, solid waste shipments, non-radioactive chemical releases, and circulating water system operation.

During 2003, the following Curies (Ci) of radioactive material were released via the liquid and atmospheric pathways:

	Liquid	Atmospheric
Tritium (Ci)	748	61.5
Particulate (Ci)	0.157	0.000237
Noble Gas (Ci)	(-)	0.866

(-)Noble gases in the liquids are added to the atmospheric release totals.
Atmospheric particulate includes radioiodines in this table.

For the purpose of regulatory compliance with the effluent design objectives of Appendix I to 10 CFR 50, doses from effluents are calculated for the hypothetical maximally exposed individual (MEI) for each age group and compared to the Appendix I objectives. Doses less than or equal to the Appendix I values are considered to be evidence that PBNP releases are as low as reasonably achievable (ALARA). The maximum annual calculated doses in millirem (mrem) or millirad (mrad) are shown below and compared to the corresponding design objectives of 10 CFR 50, Appendix I.

LIQUID RELEASES

Dose Category	Calculated Dose	Appendix I Dose
Whole body dose	0.008 mrem	6 mrem
Organ dose	0.008 mrem	20 mrem

ATMOSPHERIC RELEASES

Dose Category	Calculated Dose	Appendix I Dose
Organ dose	0.03 mrem	30 mrem
Noble gas beta air dose	0.00013 mrad	40 mrad
Noble gas gamma ray air dose	0.00035 mrad	20 mrad
Noble gas dose to the skin	0.00049 mrem	30 mrem
Noble gas dose to the whole body	0.00033 mrem	10 mrem

The results show that during 2003, the doses from PBNP effluents were a small percentage

(~ 0.1% at the most) of the Appendix I design objectives and therefore operation of PBNP continues to be ALARA.

In addition to collecting and analyzing environmental samples, a survey of land use with respect to the location of dairy cattle was made pursuant to Section 2.5 of the PBNP Environmental Manual. As in previous years, no dairy cattle were found to be grazing at the site boundary. Therefore, the assumption that cattle graze at the site boundary used in the evaluation of doses from PBNP effluents remains conservative.

The 2003 Radiological Environmental Monitoring Program (REMP) collected 813 samples for radiological analyses and 116 sets of thermoluminescent dosimeters (TLDs) to measure ambient radiation in the vicinity of PBNP and the Independent Spent Fuel Storage Installation (ISFSI). Air monitoring from six different sites showed only background radioactivity from naturally occurring radionuclides. Terrestrial monitoring consisting of soil, vegetation, and milk found no influence from PBNP. Similarly, samples from the aquatic environment, consisting of lake and well water, fish, and algae, revealed no buildup of PBNP radionuclides released in liquid effluents. The data analysis shows no plant effect on its environs.

As of December 2003, the ISFSI contained a total of 16 ventilated storage casks (VSC-24). During 2003, one cask was transferred to the ISFSI. The subset of the PBNP REMP samples used to evaluate the environmental impact of the PBNP ISFSI showed no environmental impact from its operation.

The environmental monitoring conducted during 2003 confirms that the effluent control program at PBNP ensures that its operations minimally impact the environs.

Part A
EFFLUENT MONITORING

1.0 INTRODUCTION

The PBNP effluent monitoring program is designed to comply with federal regulations for ensuring the safe operation of PBNP with respect to releases of radioactive material to the environment and its subsequent impact on the public. 10 CFR 50.34a states that operations should be conducted to keep the levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). In 10 CFR 50, Appendix I, the Nuclear Regulatory Commission (NRC) provides the numerical values for what it considers to be the appropriate ALARA design objectives to which the licensee's calculated effluent doses may be compared. These doses are a small fraction of the dose limits specified by 10 CFR 20.1301 and lower than the Environmental Protection Agency (EPA) limits specified in 40 CFR 190.

10 CFR 20.1302 directs PBNP to make the appropriate surveys of radioactive materials in effluents released to unrestricted and controlled areas. Liquid wastes are monitored by inline radiation monitors as well as by isotopic analyses of samples of the waste stream prior to discharge from PBNP. Airborne releases of radioactive wastes are monitored in a similar manner. Furthermore, for both liquid and atmospheric releases, the appropriate portions of the radwaste treatment systems are used as required to keep releases ALARA. Prior to release, results of isotopic analyses are used to adjust the release rate of discrete volumes of liquid and atmospheric wastes (from liquid waste holdup tanks and from gas decay tanks) such that the concentrations of radioactive material in the air and water beyond PBNP are below the PBNP Technical Specification concentration limits for liquid effluents and release rate limits for gaseous effluents.

Solid wastes are shipped offsite for disposal at NRC licensed facilities. The amount of radioactivity in the solid waste is determined prior to shipment in order to determine the proper shipping configuration as regulated by the Department of Transportation and the NRC.

Also operated at PBNP under the General License granted pursuant to 10 CFR 72.210 is an Independent Spent Fuel Storage Installation (ISFSI). The release of radioactive materials from the operation of the ISFSI must also comply with the limits of part 20 and the part 50 Appendix I design objectives. Per 10 CFR 72.44(d)(3), the results of radiological effluent monitoring are to be reported annually.* The dose criteria for effluents and direct radiation specified by 10 CFR 72.104 states that during normal operations and anticipated occurrences, the annual dose equivalent to any real individual

* Holders of a Part 72 license are allowed to submit the report required by 72.44(d)(3) concurrent with the effluent report required by 10 CFR 50.36a (a)(2). (Reference: 64 FR 33178)

beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. The dose from naturally occurring radon and its decay products are exempt. Because the loading of the storage casks occurs within the primary auxiliary building of PBNP, the doses from effluents due to the loading process will be assessed and quantified as part of the PBNP Radiological Effluent Control Program.

2.0 RADIOACTIVE LIQUID RELEASES

The release path to the environment contributing to radioactive liquid releases is circulating water discharge. A liquid waste treatment system in conjunction with administrative controls is used to minimize the impact on the environment and maintain doses to the public ALARA from the liquid releases.

2.1 Doses From Liquid Effluent

Doses from liquid effluent are calculated using the methodology of the Offsite Dose Calculation Manual (ODCM). These calculated doses use parameters such as the amount of radioactive material released, the total volume of liquid, the total volume of dilution water, and usage factors (e.g., water and fish consumption, shoreline and swimming factors). These calculations produce a conservative estimation of the dose. For compliance with 10 CFR 50, Appendix I design objectives, the annual dose is calculated to the hypothetical maximally exposed individual (MEI). The MEI is assumed to reside at the site boundary in the highest χ/Q sector and is maximized with respect to occupancy, food consumption, and other uses of this area. As such, the MEI represents an individual with reasonable deviations from the average for the general population in the vicinity of PBNP. A comparison of the calculated doses to the 10 CFR 50, Appendix I design objectives is presented in Table 2-1. The conservatively calculated dose to the MEI is a very small fraction of the Appendix I design objective.

Table 2-1
Comparison of 2003 Liquid Effluent Calculated Doses to
10 CFR 50 Appendix I Design Objectives

Annual Limit [mrem]	Highest Total Calculated Dose [mrem]	% of Design Objective
6 (whole body)	0.008	0.14 %
20 (any organ)	0.008	0.04 %

2.2 2003 Circulating Water Radionuclide Release Summary

Radioactive liquid releases via the circulating water discharge are summarized by individual source and total curies released on a monthly basis and presented in Table 2-2.

2.3 2003 Isotopic Composition of Circulating Water Discharges

The isotopic composition of circulating water discharges during the current reporting period is presented in Table 2-3.

2.4 Subsoil Drain System Releases Tritium Summary

The quarterly and annual results of monitoring the subsoil drains are presented in Table 2-4. No tritium was observed in any of the drains during 2003.

2.5 Changes to the Waste Liquid Treatment System in 2003

There were no changes to the liquid waste treatment system in 2003.

Table 2-2
Summary of Circulating Water Discharge
January 1, 2003, through December 31, 2003

	Jan	Feb	Mar	Apr	May	Jun	Jan-June	July	Aug	Sept	Oct	Nov	Dec	Ann
Total Activity Released (Ci)							Total							Total
Gamma Scan (Includes Fe-55)	1.84E-03	1.70E-04	1.06E-05	1.67E-03	1.31E-03	1.91E-04	5.20E-03	7.84E-02	1.26E-02	5.84E-03	1.66E-02	3.48E-02	3.85E-03	1.57E-01
Gross Alpha	3.14E-05	2.02E-07	0.00E+00	6.71E-07	0.00E+00	0.00E+00	3.23E-05	0.00E+00	3.04E-06	7.38E-06	3.75E-06	0.00E+00	1.41E-06	4.78E-05
Tritium	6.45E+01	2.18E+01	8.63E+00	2.07E+02	5.27E+01	7.78E+01	4.32E+02	1.39E+02	5.78E+01	2.64E+01	2.83E+01	3.39E+01	3.00E+01	7.48E+02
Strontium (Sr-89/90/92)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.74E-06	1.74E-06	1.95E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-05
Total Vol Released (gal)														
Processed Waste	2.28E+04	2.32E+04	7.76E+03	8.86E+04	4.83E+04	4.88E+04	2.39E+05	1.44E+05	9.33E+04	5.52E+04	1.50E+05	1.20E+05	5.74E+04	8.59E+05
Waste Water Effluent*	3.72E+06	3.58E+06	4.08E+06	4.49E+06	3.89E+06	3.39E+06	2.31E+07	3.46E+06	3.60E+06	3.97E+06	3.15E+06	4.82E+06	4.31E+06	4.64E+07
U1 SG Blowdown	2.55E+06	2.41E+06	2.68E+06	2.36E+06	2.68E+06	2.59E+06	1.53E+07	2.23E+06	2.52E+06	2.50E+06	2.53E+06	2.37E+06	2.66E+06	3.01E+07
U2 SG Blowdown	2.55E+06	2.41E+06	2.68E+06	2.80E+06	2.68E+06	9.87E+05	1.41E+07	2.50E+06	2.53E+06	2.59E+06	2.92E+05	2.19E+06	3.04E+06	2.72E+07
Total Gallons	8.84E+06	8.42E+06	9.44E+06	9.74E+06	9.29E+06	7.02E+06	5.27E+07	8.33E+06	8.74E+06	9.11E+06	6.13E+06	9.50E+06	1.01E+07	1.05E+08
Total cc	3.35E+10	3.19E+10	3.57E+10	3.69E+10	3.52E+10	2.66E+10	2.00E+11	3.15E+10	3.31E+10	3.45E+10	2.32E+10	3.59E+10	3.81E+10	3.96E+11
Vol of dilution water (cc)**	6.62E+13	5.98E+13	6.62E+13	6.41E+13	1.09E+14	1.11E+14	4.76E+14	9.64E+13	1.15E+14	1.10E+14	6.30E+13	7.57E+13	6.62E+13	1.00E+15
Avg diluted discharge conc (µCi/cc)														
Gamma Scan(incl Fe-55)	2.78E-11	2.85E-12	1.60E-13	2.61E-11	1.21E-11	1.73E-12		8.13E-10	1.10E-10	5.32E-11	2.64E-10	4.59E-10	5.82E-11	
Gross alpha	4.74E-13	3.38E-15	0.00E+00	1.05E-14	0.00E+00	0.00E+00		0.00E+00	2.64E-14	6.73E-14	5.94E-14	0.00E+00	2.13E-14	
Tritium	9.74E-07	3.65E-07	1.30E-07	3.23E-06	4.84E-07	7.03E-07		1.44E-06	5.03E-07	2.40E-07	4.49E-07	4.47E-07	4.52E-07	
Strontium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-14		1.63E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Max Batch Discharge Conc														
Tritium	3.29E-05	1.36E-05	1.26E-05	3.75E-05	2.06E-05	1.69E-05		2.14E-05	1.77E-05	8.70E-06	1.71E-05	1.28E-05	1.48E-05	
Gamma	1.37E-09	8.67E-11	1.55E-11	5.45E-10	6.43E-10	9.05E-11		1.10E-07	7.26E-09	2.99E-09	9.61E-09	1.11E-08	2.67E-09	

* The Retention Pond was taken out of service in September 2002 and replaced with the waste water effluent filter system.
** Circulating water discharge from both units.

Note: The Dissolved noble gases detected in liquid effluents (e.g., Xe-133 and Xe-135) are added to the atmospheric release summaries.

Table 2-3
Isotopic Composition of Circulating Water Discharges (Ci)
January, 2003 through December 31, 2003

							J-Jun							Annual
Nuclide	JAN	FEB	MAR	APR	MAY	JUN	Total	JUL	AUG	SEP	OCT	NOV	DEC	Total
H-3	6.45E+01	2.18E+01	8.63E+00	2.07E+02	5.27E+01	7.78E+01	4.32E+02	1.39E+02	5.78E+01	2.64E+01	2.83E+01	3.38E+01	3.00E+01	7.48E+02
F-18	0.00E+00	0.00E+00	0.00E+00	4.75E-05	0.00E+00	6.45E-05	1.12E-04	6.93E-04	1.65E-05	0.00E+00	1.66E-04	4.88E-05	4.74E-05	1.08E-03
Cr-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.78E-04	4.81E-05	7.90E-05	1.88E-03	5.26E-03	1.98E-04	8.23E-03
Mn-54	5.48E-05	3.99E-06	0.00E+00	7.00E-06	1.86E-05	0.00E+00	8.43E-05	6.38E-05	3.71E-04	8.38E-05	1.61E-04	2.50E-04	4.52E-05	1.06E-03
Fe-55	5.09E-07	7.74E-05	0.00E+00	4.02E-04	6.22E-04	0.00E+00	1.10E-03	0.00E+00	7.06E-04	5.02E-04	3.24E-03	1.36E-03	3.04E-04	7.21E-03
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-04	1.08E-04	0.00E+00	3.11E-04
Co-57	9.11E-06	0.00E+00	0.00E+00	6.93E-06	9.31E-06	0.00E+00	2.53E-05	0.00E+00	1.82E-05	8.26E-06	8.55E-06	6.64E-05	2.67E-06	1.29E-04
Co-58	7.30E-04	4.16E-05	6.19E-06	8.45E-04	3.17E-04	4.32E-05	1.98E-03	7.25E-02	6.47E-04	1.39E-03	3.13E-03	2.27E-02	2.05E-03	1.04E-01
Co-60	3.41E-04	4.19E-05	4.37E-06	1.54E-04	1.90E-04	6.59E-05	7.97E-04	4.04E-04	6.18E-03	1.37E-03	1.73E-03	1.70E-03	5.27E-04	1.27E-02
Zn-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-05	4.15E-05	0.00E+00	6.35E-05
As-76	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-05	0.00E+00	0.00E+00	2.07E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-05
Sr-92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.74E-06	1.74E-06	3.81E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.54E-06
Nb-95	4.84E-05	0.00E+00	0.00E+00	1.29E-05	2.01E-05	0.00E+00	8.14E-05	2.17E-04	2.51E-05	3.33E-05	2.46E-04	1.04E-03	8.46E-05	1.73E-03
Nb-97	0.00E+00	1.06E-06	0.00E+00	0.00E+00	0.00E+00	1.04E-05	1.15E-05	1.02E-06	0.00E+00	0.00E+00	0.00E+00	6.72E-06	0.00E+00	1.92E-05
Zr-95	3.37E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.37E-05	1.05E-04	0.00E+00	2.68E-05	9.35E-05	5.74E-04	5.56E-05	8.89E-04
Zr-97	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.14E-06	0.00E+00	0.00E+00	7.14E-06
Mo-99	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.72E-06	0.00E+00	0.00E+00	8.72E-06
Tc-99m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.45E-06	0.00E+00	0.00E+00	8.45E-06

Note: The dissolved noble gases detected in liquid effluents (e.g., Xe-133, Xe-135, etc.) are added to the atmospheric release summaries.

Table 2-3 (continued)
Isotopic Composition of Circulating Water Discharges (Ci)
January, 2003 through December 31. 2003

							J-Jun							Annual
Nuclide	JAN	FEB	MAR	APR	MAY	JUN	Total	JUL	AUG	SEP	OCT	NOV	DEC	Total
Ru-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.13E-05	0.00E+00	0.00E+00	3.13E-05
Ag-110m	4.94E-04	4.31E-06	0.00E+00	1.94E-04	1.12E-04	3.31E-06	8.08E-04	2.75E-04	6.48E-04	2.41E-04	1.10E-03	5.64E-04	2.11E-04	3.85E-03
Sn-113	9.08E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.04E-06	1.11E-05	1.58E-05	0.00E+00	0.00E+00	3.09E-04	8.04E-05	0.00E+00	4.17E-04
Sn-117m	2.06E-05	0.00E+00	0.00E+00	2.13E-06	0.00E+00	0.00E+00	2.27E-05	4.63E-06	3.79E-06	3.69E-06	9.59E-04	4.08E-04	5.14E-05	1.45E-03
Sb-122	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.25E-06	0.00E+00	0.00E+00	4.25E-06
Sb-124	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.96E-05	2.87E-04	1.35E-04	4.71E-04
Sb-125	9.46E-05	0.00E+00	0.00E+00	0.00E+00	1.07E-05	0.00E+00	1.05E-04	3.36E-03	3.92E-03	2.08E-03	3.13E-03	2.81E-04	1.42E-04	1.30E-02
I-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-06	1.97E-06
Te-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-04	0.00E+00	0.00E+00	1.17E-04
Cs-136	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.83E-06	0.00E+00	0.00E+00	0.00E+00	6.83E-06
Cs-137	0.00E+00	0.00E+00	0.00E+00	2.56E-06	1.39E-05	0.00E+00	1.64E-05	1.41E-06	3.64E-05	1.41E-05	6.68E-06	3.29E-06	0.00E+00	7.83E-05
alpha	3.14E-05	2.02E-07	0.00E+00	6.71E-07	0.00E+00	0.00E+00	3.23E-05	0.00E+00	3.04E-06	7.38E-06	3.75E-06	0.00E+00	1.41E-06	4.78E-05

Note: The dissolved noble gases detected in liquid effluents (e.g., Xe-133, Xe-135, etc.) are added to the atmospheric release summaries.

Table 2-4
Subsoil System Drains - Tritium Summary
January 1, 2003, through December 31, 2003

	S-1	S-3	S-7	S-8	S-9	S-10
1st Qtr						
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	1.41E+06	1.16E+05	7.40E+05	0.00E+00	0.00E+00	1.61E+06
2nd Qtr						
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	1.68E+06	2.32E+05	1.05E+06	0.00E+00	0.00E+00	1.44E+06
3rd Qtr						
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	2.52E+05	1.48E+05	6.21E+06	0.00E+00	5.58E+03	1.06E+06
4th Qtr						
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	3.64E+05	1.22E+05	5.36E+05	5.18E+05	0.00E+00	1.50E+06

2.6 Land Application of Sewage Sludge

The Wisconsin Department of Natural Resources has approved the disposal of PBNP sewage by land application on various Wisconsin Electric Power Company properties surrounding PBNP. This sewage sludge, which may contain trace amounts of radionuclides, are to be applied in accordance with methodologies approved by the NRC on January 13, 1988, pursuant to 10 CFR 20.302(a). The approved methodology requires analyses prior to every disposal. Based upon an investigation of the source of the radionuclides, a combination of engineering modifications and administrative controls has eliminated plant generated radiological inputs to the sewage. This was verified by sludge analyses using the environmental lower level of detection (LLD) criteria. No byproduct radionuclides were found in the sludge after the controls and modifications were completed. Sludge is routinely monitored and no radionuclides attributable to PBNP have been found.

There was no disposal of sewage by land application during 2003. All disposals were done at the Manitowoc Sewage Treatment Plant.

3.0 RADIOACTIVE AIRBORNE RELEASES

The release paths to the environment contributing to radioactive airborne release totals during this reporting period were the Auxiliary Building Vent Stack, Drumming Area Vent Stack, Unit 1 Containment Purge Stack, and Unit 2 Containment Purge Stack. A gaseous radioactive effluent treatment system in conjunction with administrative controls is used to minimize the impact on the environment from the airborne releases and maintain doses to the public ALARA.

3.1 Doses From Airborne Effluent

Doses from airborne effluent are calculated for the maximum exposed individual (MEI) following the methodology contained in the PBNP ODCM. These calculated doses use parameters such as the amount of radioactive material released, the concentration at and beyond the site boundary, the average site weather conditions, the locations of the exposure pathways (e.g., cow milk, vegetable gardens and residences), and usage factors (e.g., breathing rates, food consumption). In addition to the MEI doses, the energy deposited by beta particles and gamma rays in air is calculated and compared to the corresponding Appendix I design objectives. A comparison of the annual Appendix I design objectives for atmospheric effluents to the highest organ dose and the noble gas doses calculated using ODCM methodology is listed in Table 3-1. The doses demonstrate that releases from PBNP to the atmosphere continue to be ALARA.

3.2 Radioactive Airborne Release Summary

Radioactivity released in airborne effluents for 2003 are summarized in Table 3-2.

3.3 Isotopic Airborne Releases

The monthly isotopic airborne releases for 2003, from which the airborne doses were calculated, are presented in Table 3-3.

Table 3-1
Comparison of 2003 Airborne Effluent Calculated Doses to 10 CFR 50 Appendix I Design Objectives

Category	Annual Appendix I Design Objective	January-December Calculated Dose	Percent of Appendix I Design Objective
Particulate	30 mrem/organ	0.0312 mrem	1.04E-01
Noble gas	40 mrad (beta air)	0.000127 mrad	3.18E-04
Noble gas	20 mrad (gamma air)	0.000345 mrad	1.73E-03
Noble gas	30 mrem/organ	0.000485 mrem	1.62E-03
Noble gas	10 mrem (whole body)	0.000328 mrem	3.28E-03

Table 3-2
Radioactive Airborne Effluent Release Summary
January 1, 2003, through December 31, 2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total NG from Liq (Ci)	3.49E-05	0.00E+00	0.00E+00	1.26E-03	1.52E-04	6.50E-05	1.22E-03	1.07E-04	0.00E+00	5.89E-04	6.88E-04	4.32E-05	4.15E-03
Total NG from Atm (Ci)	7.68E-02	6.05E-02	8.11E-02	8.01E-02	1.24E-01	6.99E-02	5.80E-02	8.34E-02	7.70E-02	4.33E-02	5.40E-02	8.22E-02	8.90E-01
Total Noble Gas (Ci)[1]	7.68E-02	6.05E-02	8.11E-02	8.14E-02	1.24E-01	7.00E-02	5.92E-02	8.35E-02	7.70E-02	4.39E-02	5.47E-02	8.22E-02	8.94E-01
Total Radioiodines (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.39E-07	3.66E-06	2.35E-05	0.00E+00	0.00E+00	1.22E-04	0.00E+00	0.00E+00	1.50E-04
Total Particulates (Ci)[2]	0.00E+00	0.00E+00	0.00E+00	3.12E-05	1.10E-05	3.62E-05	8.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.70E-05
Alpha (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
All Others (gamma) (Ci)	0.00E+00	0.00E+00	0.00E+00	3.12E-05	1.10E-05	3.62E-05	8.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.70E-05
Total Tritium (Ci)	6.70E+00	6.29E+00	6.90E+00	4.98E+00	6.01E+00	5.13E+00	4.63E+00	4.50E+00	3.37E+00	6.01E+00	3.18E+00	3.77E+00	6.15E+01
Max Hourly Release (Ci/sec)	9.10E-08	8.26E-08	8.24E-08	8.56E-08	9.02E-08	8.23E-08	7.71E-08	8.71E-08	9.07E-08	1.12E-07	8.97E-08	8.12E-08	(-)

[1] Includes noble gas contribution from liquid releases.
[2] Total Particulate is the sum of alpha, strontium, and others. It does not include radioiodines.

TABLE 3-3
Isotopic Composition of Airborne Releases
January 1, 2003 through December 31, 2003

Nuclide	Jan (Ci)	Feb (Ci)	Mar (Ci)	Apr (Ci)	May (Ci)	Jun (Ci)	Semi-Annual	Jul (Ci)	Aug (Ci)	Sep (Ci)	Oct (Ci)	Nov (Ci)	Dec (Ci)	Total (Ci)
H-3	6.70E+00	6.29E+00	6.90E+00	4.98E+00	6.01E+00	5.13E+00	3.60E+01	4.63E+00	4.50E+00	3.37E+00	6.01E+00	3.18E+00	3.77E+00	6.15E+01
Ar-41	6.69E-02	5.53E-02	7.85E-02	7.54E-02	9.04E-02	6.36E-02	4.30E-01	4.73E-02	7.86E-02	7.44E-02	2.83E-02	4.02E-02	7.79E-02	7.77E-01
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.95E-04
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-05	0.00E+00	7.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-05
Xe-133	9.77E-03	5.30E-03	2.66E-03	4.74E-03	3.28E-02	6.28E-03	6.16E-02	9.83E-03	4.77E-03	2.62E-03	1.49E-02	1.38E-02	4.29E-03	1.12E-01
Xe-133m	0.00E+00	0.00E+00	0.00E+00	1.05E-05	2.48E-04	0.00E+00	2.59E-04	5.37E-04	0.00E+00	0.00E+00	4.11E-05	0.00E+00	0.00E+00	8.37E-04
Xe-135	8.13E-05	0.00E+00	0.00E+00	1.18E-05	0.00E+00	0.00E+00	9.32E-05	2.72E-06	0.00E+00	0.00E+00	6.30E-05	0.00E+00	0.00E+00	1.59E-04
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E-04	0.00E+00	3.46E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E-04
F-18	0.00E+00	0.00E+00	0.00E+00	3.12E-05	1.10E-05	3.62E-05	7.84E-05	1.54E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E-05
Mo-99	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.34E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.34E-06
Tc-99m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-06
I-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.39E-07	0.00E+00	9.39E-07	2.35E-05	0.00E+00	0.00E+00	1.22E-04	0.00E+00	0.00E+00	1.46E-04
I-132	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-08	0.00E+00	0.00E+00	1.82E-08
I-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E-06	3.66E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E-06

Note: The Noble Gases listed above do not include the liquid contribution.

4.0 RADIOACTIVE SOLID WASTE SHIPMENTS

4.1 Types, Volumes, and Activity of Shipped Solid Waste

The following types, volumes, and activity of solid waste were shipped from PBNP for offsite disposal or burial during 2003. No types C or D were shipped. No irradiated fuel was shipped offsite. The volume, activity, and type of waste are listed in Table 4-1.

Table 4-1
Quantities and Types of Waste Shipped from PBNP

Type of Waste	Quantity	Activity
A. Spent resins, filter sludge, evaporator bottoms, etc.	17.30 m^3	175.25 Ci
	611.10 ft^3	
B. Dry compressible waste, contaminated equipment, etc	232.20 m^3	0.0989 Ci
	8200.00 ft^3	
C. Irradiated components, control rods, etc.	0.00 m^3	N/A Ci
	0.00 ft^3	
D. Other	0.00 m^3	N/A Ci
	0.00 ft^3	

4.2 Major Nuclide Composition (by Type of Waste)

The major radionuclide content of the solid waste was determined by gamma isotopic analysis and the application of scaling factors for certain indicator radionuclides based on the measured isotopic content of representative waste stream samples. The estimated isotopic content is presented in Table 4-2.

Table 4-2
Estimated Solid Waste Major Radionuclide Composition

TYPE A		TYPE B		TYPE C		TYPE D	
	Percent		Percent		Percent		Percent
Nuclide	Abundance	Nuclide	Abundance	Nuclide	Abundance	Nuclide	Abundance
Ni-63	6.01E+01	Co-60	3.20E+01				
Fe-55	1.99E+01	Ni-63	2.59E+01				
Co-60	1.12E+01	Fe-55	1.95E+01				
Co-58	2.02E+00	Co-58	1.12E+01				
Mn-54	1.99E+00	Cs-137	4.81E+00				
Ce-144	1.33E+00	Sb-125	1.57E+00				
Cs-137	1.07E+00	H-3	1.49E+00				
H-3	1.03E+00	Nb-95	1.42E+00				
Sb-125	6.36E-01	Ag-110	1.24E+00				
Ni-59	3.60E-01	C-14	2.74E-01				
Ag-110	1.49E-01	Pu-241	2.39E-01				
Pu-241	7.72E-02	Ni-59	1.48E-01				
Tc-99	6.36E-02	Sr-90	7.91E-02				
Nb-95	3.83E-02	Nb-94	6.99E-02				
Sr-90	2.13E-02	Am-241	3.43E-02				
C-14	1.84E-02	Pu-239	2.30E-02				
Ru-106	1.39E-02	Pu-238	1.29E-02				
Pu-238	4.14E-04	Cm-243	8.98E-03				
Cm-243	3.41E-04	Cm-242	2.96E-03				
Am-241	2.56E-04	Tc-99	6.17E-07				
Pu-239	2.54E-04	I-129	3.98E-07				
Cm-244	2.32E-04						
Pu-240	2.15E-04						
Cm-242	1.33E-04						
I-129	6.62E-08						

4.3 Solid Waste Disposition

There were 10 solid waste shipments from PBNP during 2003. The dates and destinations were:

Table 4-3
PBNP Radioactive Waste Shipments

Date	Destination	Date	Destination
31-Jan	Erwin, TN		
7-Feb	Wampum, PA		
13-Feb	Oak Ridge,TN		
17-Mar	Erwin, TN		
23-Apr	Wampum, PA		
9-May	Memphis, TN		
23-May	Oak Ridge,TN		
23-May	Memphis, TN		
10-Sep	Wampum, PA		
20-Nov	Oak Ridge,TN		

5.0 NONRADIOACTIVE CHEMICAL RELEASES

5.1 Scheduled Chemical Waste Releases

Scheduled chemical waste releases to the circulating water system from January 1, 2003, to June 30, 2003, included 5.94E+05 gallons of neutralized wastewater. The wastewater contained 8.40E+00 pounds of suspended solids and 1.93E+04 pounds of dissolved solids.

Scheduled chemical waste releases to the circulating water system from July 1, 2003, to December 31, 2003, included 5.91E+05 gallons of neutralized wastewater. The wastewater contained 7.54E+00 pounds of suspended solids and 1.53E+04 pounds of dissolved solids.

Scheduled chemical waste releases are based on the average analytical results obtained from sampling a representative number of neutralizing tanks.

5.2 Miscellaneous Chemical Waste Releases

Miscellaneous chemical waste releases from the Wastewater Effluent (based on effluent analyses) to the circulating water for January 1, 2003, to June 30, 2003, included 2.31E+07 gallons of clarified wastewater. The wastewater contained 2.43E+03 pounds of suspended solids.

Miscellaneous chemical waste releases from the Wastewater Effluent (based on effluent analyses) to the circulating water for July 1, 2003, to December 31, 2003, included 2.33E+07 gallons of clarified wastewater. The wastewater contained 3.22E+03 pounds of suspended solids.

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from January 1, 2003, to June 30, 2003, included 7.86E+04 pounds of sodium bisulfite and 2.31E+04 pounds of sodium hypochlorite.

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from July 1, 2003, to December 31, 2003, included 1.28E+05 pounds of sodium bisulfite and 3.47E+04 pounds of sodium hypochlorite.

6.0 CIRCULATING WATER SYSTEM OPERATION

The circulating water system operation during this reporting period for periods of plant operation is described in Table 6-1.

Table 6-1
Circulating Water System Operation for 2003

	UNIT	JAN	FEB	MAR	APR	MAY	JUN
Average Volume Cooling	1	282.2	282.2	282.2	282.2	477.4	487.3
Water Discharge [million gal/day]**	2	282.2	282.2	282.2	282.2	450.5	485.5
Average Cooling Water	1	41	38	39	39	49	53
Intake Temperature [°F]	2	42	39	39	39	49	53
Average Cooling Water	1	71	69	70	70	68	71
Discharge Temperature [°F]	2	75	72	73	67*	68	72
Average Ambient Lake Temperature [°F]		40	40	42	43	54	58

*Unit 2 shutdown from Apr 6 - 9, 2003.
** For days with cooling water discharge flow.

Table 6-1(continued)
Circulating Water System Operation for 2003

	UNIT	JUL	AUG	SEP	OCT	NOV	DEC
Average Volume Cooling	1	401.9	488.9	490.0	475.6	391.8	282.2
Water Discharge [million gal/day]**	2	420.6	488.3	476.0	256.2	274.8	282.2
Average Cooling Water	1	54	61	54	46	42	37
Intake Temperature [°F]	2	54	61	54	47 ·	42	38
Average Cooling Water	1	68*	81	73	66	67	69
Discharge Temperature [°F]	2	73*	81	72	56*	54*	71
Average Ambient Lake Temperature [°F]		58	66	59	52	47	42

*Unit 1 shutdown July 15-24,2003. Unit 2 shutdown July 10-13 and Oct 4 - Nov 18, 2003.
** For days with cooling water discharge flow.

Part B
Miscellaneous Reporting Requirements

7.0 ADDITIONAL REPORTING REQUIREMENTS

7.1 Revisions to the PBNP Effluent and Environmental Programs

The PBNP Offsite Dose Calculation Manual, the Radiological Effluent Control Manual, and the Environmental Manual were revised during 2003.

The Environmental Manual revision included the replacement of one milk sampling site and the elimination of the formal, quarterly air sampler leak check. The dairy farm, REMP collection site E-19, northwest of PBNP went out of the dairy business and was replaced by another dairy farm (designated E-40) south of E-19 and in the same wind rose sector. The elimination of the formal, quarterly leak checks was based on the review of the past two years data which indicated that the weekly leak checks are sufficient to identify problems. A complete leak check is performed as part of the annual calibration.

The ODCM changes involve removing Appendices E - H and replacing them with references to the documents comprising the appendices. The other changes included replacing two figures with ones that are more legible and revising references and parameters associated with the abandoned retention pond with its replacement, the waste water effluent system.

The Radiological Effluent Control Manual was revised to address the replacement of the abandoned retention pond by the waste water effluent system and to add information on the storage of meteorological data.

7.2 Interlaboratory Comparison Program

Environmental, Inc, Midwest Laboratory, the analytical laboratory contracted to perform the radioanalyses of the PBNP environmental samples, participated in the interlaboratory comparison studies administered by Environmental Resources Associates during 2003. The results of this comparison can be found in Appendix A of the AMR.

7.3 Special Circumstances

No special circumstances report regarding operation of the explosive gas monitor for the waste gas holdup system was needed during 2003.

Part C
RADIOLOGICAL ENVIRONMENTAL MONITORING

8.0 INTRODUCTION

The objective of the PBNP REMP is to determine whether the operation of PBNP or the ISFSI has radiologically impacted the environment. To this end, the REMP collects and analyzes air, water, milk, soil, vegetation, and fish samples for radionuclides and uses thermoluminescent dosimeters (TLDs) to determine the ambient radiation background. These measurements also serve as a check of the efficacy of PBNP effluent controls. The REMP fulfills the requirements of 10 CFR 20.1302, PBNP General Design Criterion (GDC) 17, GDC 64 of Appendix A to 10 CFR 50, and Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50 for the operation of the plant. Therefore, the REMP collects samples from various environmental media in order to provide data on measurable levels of radiation and radioactive materials in the principal pathways of environmental exposure.

A subset of the PBNP REMP samples, consisting of air, soil, and vegetation, also fulfills 10 CFR 72.44(d)(2) for operation of the ISFSI. Additionally, TLDs provide the means to measure changes in the ambient environmental radiation levels at sites near the ISFSI and at the PBNP site boundary to ensure that radiation levels from the ISFSI are maintained within the dose limits of 10 CFR 72.104. Because the ISFSI is within the PBNP site boundary, radiation doses from PBNP and the ISFSI, combined, must be used to assess compliance with 10 CFR 72.122 and 40 CFR 190. Therefore, radiological environmental monitoring for the ISFSI is provided by selected sampling sites, which are part of the PBNP REMP.

For the aquatic environment, the samples include water as well as the biological integrators, such as fish and filamentous algae. Because of their migratory behavior, fish are wide area integrators. In contrast, the filamentous algae periphyton is attached to shoreline rocks and concentrate nuclides from the water flowing by their point of attachment. Grab samples of lake water provide a snapshot of radionuclide concentrations at the time the sample is taken; where as analysis of fish and filamentous algae yield concentrations over time.

The air-grass-cow-milk exposure pathway unites the terrestrial and atmospheric environments. This pathway is important because of the many dairy farms around PBNP. Therefore, the REMP includes samples of air, general grasses, and milk from the PBNP environs. An annual land use survey is made to determine whether the assumptions on the location of dairy cattle remain conservative with respect to dose calculations for PBNP effluents. The dose calculations assume that the dairy cattle are located at the south site boundary, the highest depositional sector. In addition, soil samples are collected and analyzed in order to monitor the potential for long-term buildup of radionuclides in the vicinity of PBNP.

For the measurement of ambient environmental radiation levels that may be affected by direct radiation from PBNP or by noble gas effluents, the REMP employs a series of TLDs situated around PBNP and the ISFSI.

9.0 PROGRAM DESCRIPTION

9.1 Results Reporting Convention

The vendor used by PBNP to analyze the environmental samples is directed to report analysis results as measured by a detector, which can meet the required lower level of detection (LLD) as specified in Table 2-2 of the Environmental Manual for each sample. The report provided by the vendor (see the Appendix) contains values, which can be either negative, positive or zero plus/minus the two sigma counting uncertainty, which provides the 95% confidence level for the measured value.

The LLD is an *a priori* concentration value that specifies the performance capability of the counting system used in the analyses of the REMP samples. The parameters for the *a priori* LLD are chosen such that only a five percent chance exists of falsely concluding a specific radionuclide is present when it is not present at the specified LLD. Based on detector efficiency and average background activity, the time needed to count the sample in order to achieve the desired LLD depends upon the sample size. Hence, the desired LLD may be achieved by adjusting various parameters. When a suite of radionuclides are required to be quantified in an environmental sample such as lake water, the count time used is that required to achieve the LLD for the radionuclide with the longest counting time. Therefore, in fulfilling the requirement for the most difficult to achieve radionuclide LLD, the probability of detecting the other radionuclides is increased because the counting time used is longer than that required to achieve the remaining radionuclide LLDs.

The REMP results in this report are reported as averages of the measurements made throughout the calendar year plus/minus the associated standard deviation. If all net sample concentrations are equal to or less than the LLD, the result is reported as "Not Detectable" (ND), indicating no detectable level of activity present in the sample. If any of the net sample concentrations indicate a positive result (i.e., greater than the LLD), all of the data reported are used to generate the reported statistics. Because of the statistical nature of radioactive decay, when the radionuclide of interest is not present in the sample, negative and positive results centered about zero will be seen. Excluding validly measured concentrations, whether negative or as small positive values below the LLD, artificially inflates the calculated average value. Therefore, all generated data are used to calculate, when applicable, the statistical parameters (i.e., average, standard deviation) presented in this report.

In interpreting the data, effects due to the plant must be distinguished from those due to other sources. A key interpretive aid in assessment of these effects is the design of the PBNP REMP, which is based upon the indicator-control concept. Most types of samples are collected at both indicator locations (e.g., nearby, downwind, or down stream) and at control locations (e.g., distant, upwind, or upstream). A plant effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than could be accounted for by typical fluctuation in radiation levels arising from other sources.

9.2 Sampling Parameters

Samples are collected and analyzed at the frequency indicated in Table 9-1 from the locations described in Table 9-2 and shown in Figures 9-1, 9-2, and 9-3. (The latter two figures show sampling locations not shown in preceding figures due to space limitations.) The PBNP REMP sampling site used to determine environmental impact around the ISFSI are found in Table 9-3. The minimum acceptable sample size is found in Table 9-4. In addition, Table 9-1 indicates the collection and analysis frequency of the ISFSI fence TLDs.

9.3 Deviations from Required Collection Frequency

Deviations from the collection frequency given in Table 9-1 are allowed because of hazardous conditions, automatic sampler malfunction, seasonal unavailability, and other legitimate reasons (Section 2.2.6 of the Environmental Manual). Table 9-5 lists deviations from the scheduled sampling and frequency, which occurred during the reporting period.

9.4 Assistance to the State of Wisconsin

The Radiation Protection Unit of the Wisconsin Department of Health and Family Services maintains a radiological environmental monitoring program in order to confirm the results from the PBNP REMP. As a courtesy to the State of Wisconsin, PBNP personnel also collect certain environmental samples (Table 9-6) for the State from sites, which are near PBNP sampling sites or are co-located. The results of the State monitoring program are available from the Radiation Protection Unit of the Wisconsin Department of Health and Family Services.

9.5 Program Modifications

During 2003, milk sampling site E-19 was terminated and replaced by E-40. E-40 is located in the same wind rose sector as E-19. Air sampler quarterly leak checks were eliminated.

Table 9-1
PBNP REMP Sample Analysis and Frequency

Sample Type	Sample Codes	Analyses	Frequency
Environmental Radiation Exposure	E-01, -02, -03, -04, -05, -06, -07, -08, -09, -12 -14, -15, -16, -17, -18, -20, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -32, -38, -39, -TC	TLD	Quarterly
Vegetation	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta	3x/yr as available Gamma Isotopic Analysis
Algae	E-05, -12	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Fish	E-13	Gross Beta Gamma Isotopic Analysis (Analysis of edible portions only)	3x/yr as available
Well Water	E-10	Gross Beta, H-3 Sr-89, 90, I-131 Gamma Isotopic Analysis (on total solids)	Quarterly
Lake Water	E-01, -05, -06, -33	Gross Beta I-131 Gamma Isotopic Analysis (on total solids)	Monthly / Quarterly composite of monthly collections Monthly Monthly
Milk	E-11, -21, -40	Sr-89, 90 I-131 Gamma Isotopic Analysis	Monthly
Air Filters	E-01, -02, -03, -04, -08, -20	Gross Beta I-131 Gamma Isotopic Analysis	Weekly (particulate) Weekly (charcoal) Quarterly (on composite particulate filters)
Soil	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	2x/yr
Shoreline Sediment	E-01, -05, -06, -12, -33,	Gross Beta Gamma Isotopic Analysis	2x/yr
ISFSI Ambient Radiation Exposure	North, East, South, West Fence Sections	TLD	Quarterly

Table 9-2
PBNP REMP Sampling Locations

Location Code	Location Description
E-01	Primary Meteorological Tower South of the Plant
E-02	Site Boundary Control Center - East Side of Building
E-03	Tapawingo Road, about 0.4 Miles West of Lakeshore Road
E-04	North Boundary
E-05	Two Creeks Park
E-06	Point Beach State Park - Coast Guard Station; TLD located South of the Lighthouse on Telephone pole
E-07	WPSC Substation on County V, about 0.5 Miles West of Hwy 42
E-08	G.J. Francar Property at Southeast Corner of the Intersection of Cty. B and Zander Road
E-09	Nature Conservancy
E-10	PBNP Site Well
E-11	Dairy Farm about 3.75 Miles West of Site
E-12	Discharge Flume/Pier
E-13	Pumphouse
E-14	South Boundary, about 0.2 miles East of Site Boundary Control Center
E-15	Southwest Corner of Site
E-16	WSW, Hwy 42, a residence about 0.25 miles North of Nuclear Road
E-17	North of Mishicot, Cty. B and Assman Road, Northeast Corner of Intersection
E-18	Northwest of Two Creeks at Zander and Tannery Roads
E-40	Local Dairy Farm, W side of Hwy 42, about 1.8 miles north of the Nuclear Rd intersection
E-20	Reference Location, 17 miles Southwest, at Silver Lake College
E-21	Local Dairy Farm just South of Site on Lakeshore and Irish Roads
E-22	West Side of Hwy 42, about 0.25 miles North of Johanek Road
E-23	Greenfield Lane, about 4.5 Miles South of Site, 0.5 Miles East of Hwy 42
E-24	North Side of County Rt. V, near intersection of Saxonburg Road
E-25	South Side of County Rt. BB, about 0.5 miles West of Norman Road
E-26	804 Tapawingo Road, about 0.4 miles East of Cty. B, North Side of Road
E-27	Intersection of Saxonburg and Nuclear Roads, Southwest Corner, about 4 Miles WSW
E-28	TLD site on western most pole between the 2nd and 3rd parking lots.
E-29	Area of North Meteorological Tower.
E-30	NE corner at Intersection of Tapawingo and Lakeshore Roads.
E-31	On utility pole North side of Tapawingo Road closest to the gate at the West property line.
E-32	On a tree located at the junction of property lines, as indicated by trees and shrubs, about 500 feet east of the west gate on Tapawingo Road and about 1200 feet south of Tapawingo Road. The location is almost under the power lines between the blue and gray transmission towers.
E-33	Lake Michigan shoreline accessed from the SE corner of KNPP parking lot. Sample South of creek.
E-38	Tree located at the West end of the area previously containing the Retention Pond.
E-39	Tree located at the East end of the area previously containing the Retention Pond.
E-TC	Transportation Control; Reserved for TLDs

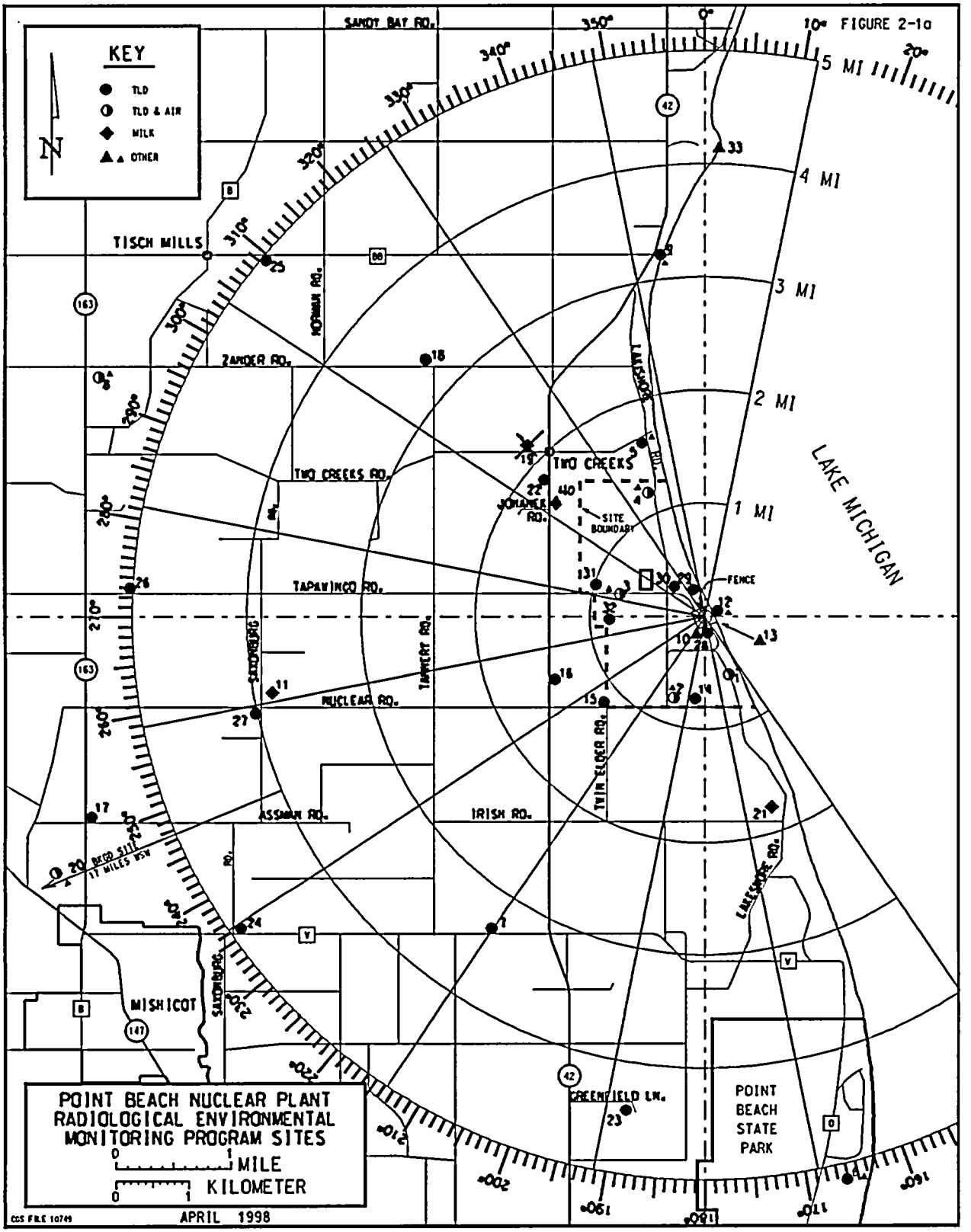


Figure 9-1
PBNP REMP Sampling Sites

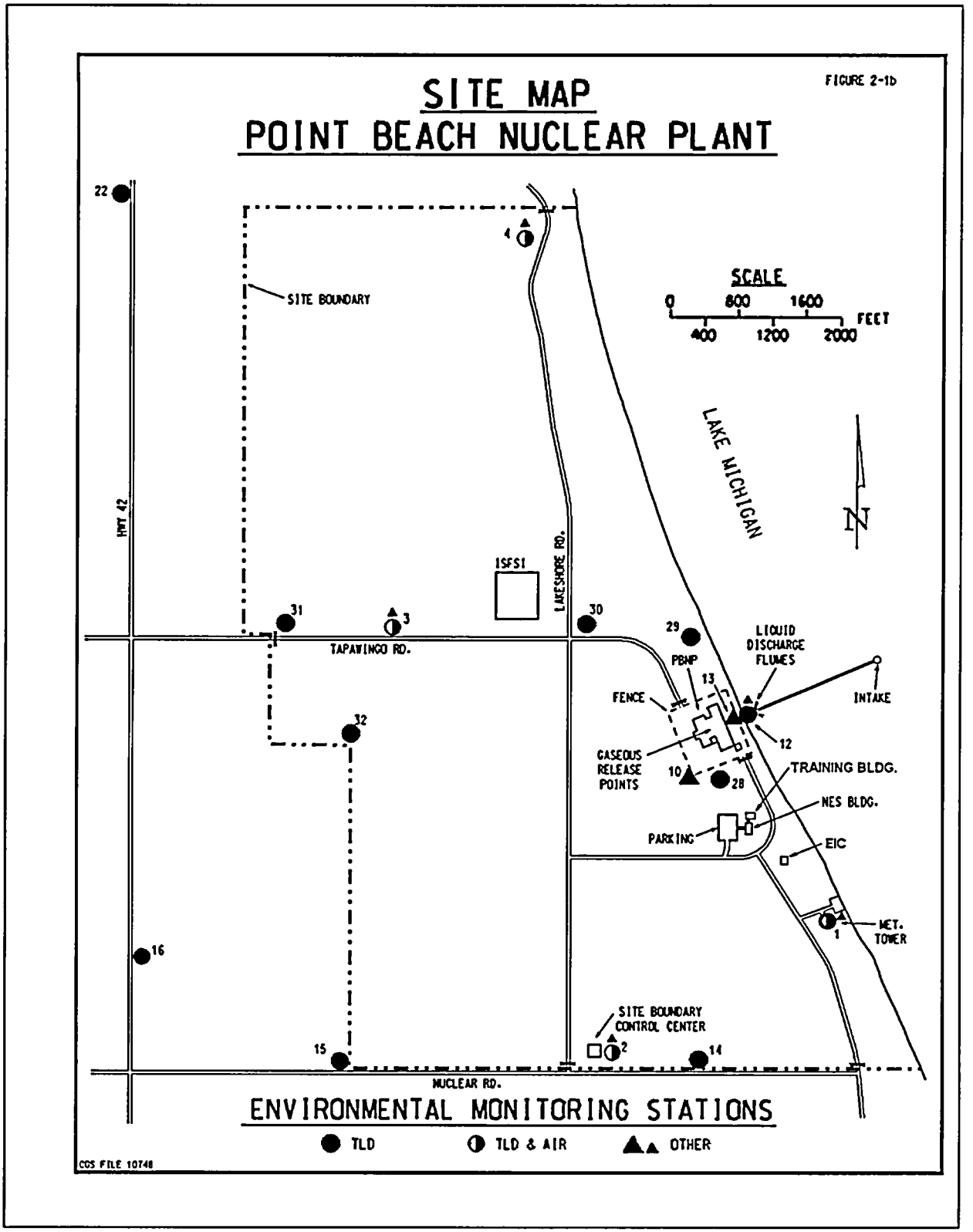


Figure 9-2
Map of REMP Sampling Sites Located Around PBNP

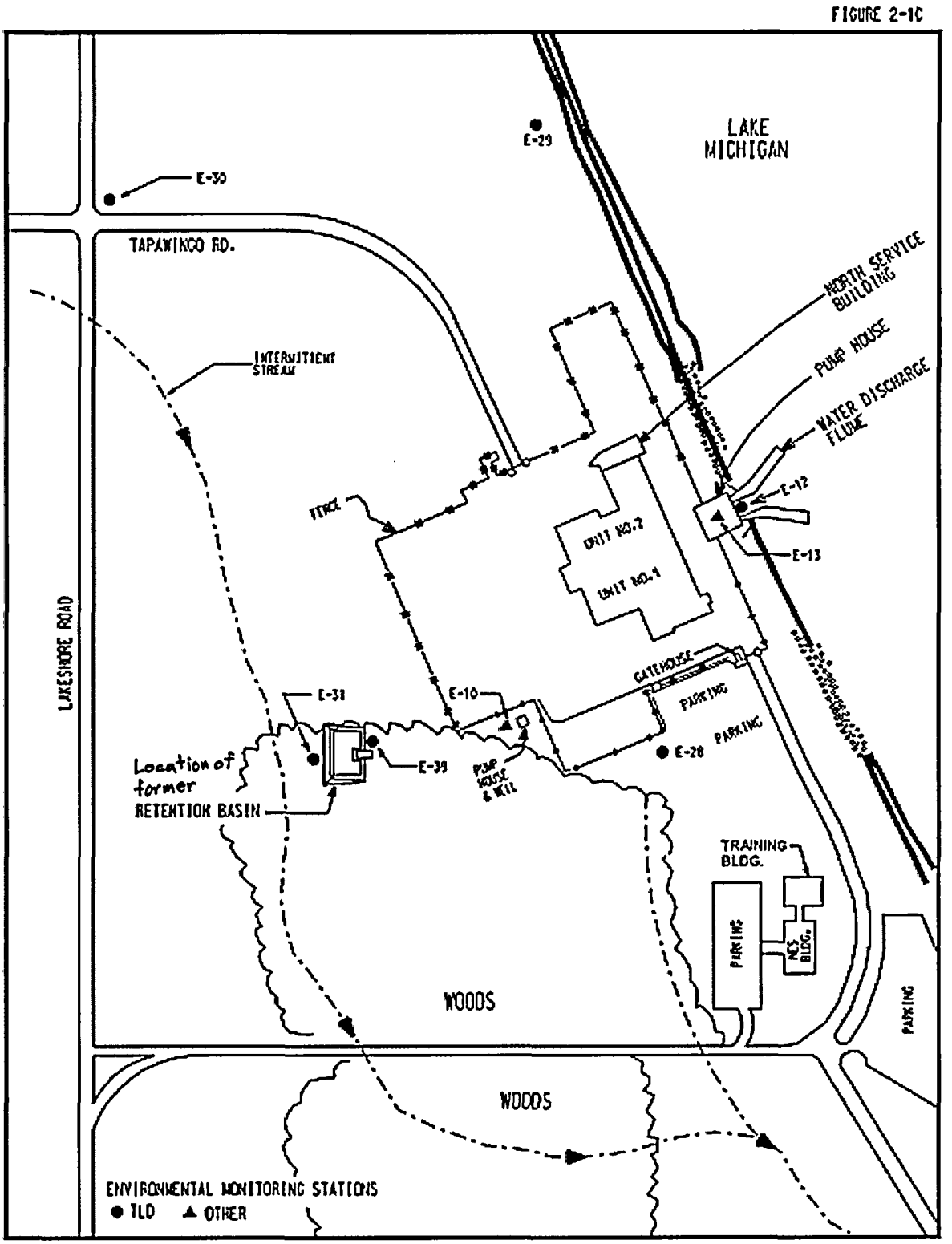


Figure 9-3
Enhanced Map Showing REMP Sampling Sites Closest to PBNP

Table 9-3
ISFSI Sampling Sites

Ambient Radiation Monitoring (TLD)	Soil, Vegetation, and Airborne Monitoring
E-03	E-02
E-28	E-03
E-30	E-04
E-31	
E-32	

Table 9-4
Minimum Acceptable Sample Size

Sample Type	Size
Vegetation	100-1000 grams
Lake Water	8 liters
Air Filters	250 m3 (volume of air)
Well Water	8 liters
Milk	8 liters
Algae	100-1000 grams
Fish (edible portions)	1000 grams
Soil	500-1000 grams
Shoreline Sediment	500-1000 grams

Table 9-5
Deviations from Scheduled Sampling and Frequency

Sample Type	Location	Collection Date	Reason for not conducting REMP as required	Plans for Preventing Recurrence
LW	E-06	1/15/2003	Sample unavailable due to ice.	Ice conditions are not controllable. Samples missed due to environmental conditions are expected and is so noted in Section 2.2.6 of the Environmental Manual.
AP/AI	E-02	6/18/2003 8/06/2003	Sample unavailable due to loss of power to the pump The sampling volume could not be quantified.	Power loss at E-02 continues from 2002. Evaluations continue to determine the cause(s) so that corrections can be made.
algae (SL)	E-12	6/6/2003	No algae sample was available. All algae was in deep water and not in shallow water where it could be reached.	Samples missed due to environmental conditions are expected and is so noted in Section 2.2.6 of the Environmental Manual.

Table 9-6
Sample Collections for State of Wisconsin

Sample Type	Location	Frequency
Lake Water	E-01	Weekly, Composited Monthly
Air Filters	E-07 E-08	Weekly
Fish	E-13	Quarterly, As Available
Precipitation	E-04 E-08	Twice a month, As Available
Milk	E-11 E-19	Monthly
Well Water	E-10	Twice per year

9.6 Analytical Parameters

The types of analyses and their frequencies are given in Table 9-1. The LLDs for the various analyses are found in the Section 10 (Table 10-1) with the summary of the REMP results. All environmental LLDs listed in Table 2-2 of the Environmental Manual (also in Table 10-1) were achieved during 2003.

9.7 Brief Description of Analytical Parameters in Table 9-1

9.7.1 Gamma isotopic analysis

Gamma isotopic analysis consists of a computerized scan of the gamma ray spectrum from 80 keV to 2048 keV. Specifically included in the scan are Mn-54, Fe-59, Co-58, Co-60, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Ba-La-140, Cs-134, Cs-137, Ce-141, and Ce-144. However, any other nuclear power plant produced radionuclides, which are detected, also are noted. Naturally occurring radionuclides such as Ra-226, Bi-214, Pb-212, Tl-208, Ac-228, Be-7, and K-40 are frequently detected in soil, sediment, and vegetation but are not normally reported. All radionuclides detected by gamma isotopic analysis are decay corrected to the time of collection.

9.7.2 Gross Beta Analysis

Gross beta analysis is a non-specific analysis that consists of measuring the total beta activity of the sample. No individual radionuclides are identifiable by this method. Gross beta analysis is a quick method of surveying samples for the presence of elevated activity that may require additional, immediate analyses.

9.7.3 Water Samples

Water samples include both Lake Michigan and well water. The Lake Michigan samples are collected along the shoreline at four locations north and south of PBNP. The well water is sampled from the on-site PBNP well. Gross beta and gamma isotopic analytical results for water are obtained by measurements on the solids remaining after evaporation of the unfiltered sample to dryness. Hence, the results are indicated as "on total solids" in Table 10-1.

9.7.4 Air Samples

Particulate air filters are allowed to decay at least 72 hours before gross beta measurements are made in order for naturally occurring radionuclides to become negligible part of the total activity. Gross beta measurements serve as a quick check for any unexpected activity that may require immediate investigation. Quarterly composites of the particulate air filters are analyzed for long-lived radionuclides such as Cs-134 and Cs-137. Charcoal filters are counted as soon as possible so the I-131 will undergo only minimal decay prior to analyses.

In order to ensure that the air sampling pumps are operating satisfactorily, a gross leak check is performed weekly. The pumps are changed out annually for calibration and maintenance beyond what can be accomplished in the field.

9.7.5 Vegetation

Vegetation samples consist predominantly of green, growing plant material (grasses and weeds most likely to be eaten by cattle if they were present at the sampling site). Care is taken not to include any dirt associated with roots by cutting the vegetation off above the soil line.

9.7.6 Environmental Radiation Exposure

Environmental radiation exposure measurements taken in 2003 were performed with TLD cards. The TLDs absorb the energy deposited in them by gamma rays. The TLD card is a small passive detector, which integrates exposure through the use of a crystalline phosphorus material, calcium sulfate containing dysprosium. Each TLD consists of a single Teflon sheet coated with calcium sulfate, which is read in four distinct quadrants to yield four values of exposure. This dosimeter design provides exposure information by averaging the four measured values. Prior to the third quarter of 2001, previous years' data were collected with TLDs that consisted of three lithium fluoride chips sealed in black plastic. The difference in material types can impact the amount of exposure

measured. As seen in the 2001 Environmental Inc., typically the TLD cards produce a higher measured value, although within the uncertainty of that value recorded by the TLD chips.

The reported field exposure is the arithmetic average of the four exposure values obtained minus the exposure received while the field TLD is in storage and transit.

The gamma rays may originate from PBNP produced radionuclides or from naturally occurring radionuclides. The TLDs remain at the monitoring site for roughly three months prior to analyses and the results are reported as mrem per seven days. Because the TLDs are constantly bombarded by naturally occurring gamma radiation, even during shipment to and from PBNP, the amount of exposure during transportation is measured using transportation controls with each shipment of TLDs to and from the laboratory. The doses recorded on the transportation controls are subtracted from the monitoring TLDs in order to obtain the net *in situ* dose.

9.7.7 ISFSI Ambient Radiation Exposure

Although the ISFSI fence TLDs are not considered part of the REMP because of their location directly on site, their results can be used indirectly to determine whether the operation of the ISFSI is having an impact on the ambient environmental radiation beyond the site boundary. Impacts are determined by comparison of fence TLD results to the results of the monitoring at PBNP site boundary and other selected locations.

10.0 RESULTS

Summary of 2003 REMP Results

Radiological environmental monitoring conducted at PBNP from January 1, 2003, through December 31, 2003, consisted of analysis of air filters, milk, lake water, well water, soil, fish, shoreline sediments, algae, and vegetation as well as TLDs. The results are summarized in Table 10-1.

Table 10-1 contains the following information:

Sample:	Type of the sample medium
Description:	Type of measurement
LLD:	*a priori* lower limit of detection
N:	Number of samples analyzed
Average:	Average value ± the standard deviation of N samples
High:	Highest measured value ± its associated 2 sigma counting error
Units:	Units of measurement

Table 10-2 contains the ISFSI fence TLD results.

For certain analyses, an LLD which is lower than that required by REMP is used because the lower value derives from the counting time required to obtain the LLDs for radionuclides that are more difficult to detect. For these analyses, both LLDs are listed with the REMP LLD given in parentheses. The results are discussed in the narrative portion of this report (Section 11). Blank values have not been subtracted from the results presented in Table 10-1. A complete listing of all the individual results obtained from the contracted analytical laboratory and the laboratory's radioanalytical quality assurance results and Interlaboratory Crosscheck Program results are presented in the Appendix.

Table 10-1
Summary of Radiological Environmental Monitoring Results for 2003

Sample	Description	N	LLD (a)	Average ± Standard Deviation (b)	High ± 2 sigma	Units
TLD	Environmental Radiation	112	1 mrem	1.05 ± 0.16	1.45 ± 0.16	mR/7days
	Control (E-20)	4	1 mrem	0.99 ± 0.08	1.07 ± 0.13	mR/7days
Air	Gross Beta	258	0.01	0.023 ± 0.008	0.045 ± 0.005	pCi/m3
	Control (E-20) Gross beta	52	0.01	0.025 ± 0.009	0.052 ± 0.005	pCi/m3
	I-131	258	0.030 (0.07)	0.000 ± 0.007	0.021 ± 0.007	pCi/m3
	Control (E-20) I-131	52	0.030 (0.07)	0.001 ± 0.006	0.017 ± 0.007	pCi/m3
	Cs-134	20	0.05	ND	-	pCi/m3
	Cs-137	20	0.06	ND	-	pCi/m3
	Other gamma emitters	20	0.1	ND	-	pCi/m3
Milk	Sr-89	36	5	ND	-	pCi/L
	Sr-90	36	1	1.1 ± 0.4	2.5 ± 0.4	pCi/L
	I-131	36	0.5	ND	-	pCi/L
	Cs-134	36	5 (15)	ND	-	pCi/L
	Cs-137	36	5 (18)	ND	-	pCi/L
	Ba-La-140	36	5 (15)	ND	-	pCi/L
	Other gamma emitters	36	15	ND	-	pCi/L
Well	Gross beta	4	4	ND	-	pCi/L
Water	H-3	4	500 (3000)	ND	-	pCi/L
	Sr-89	4	5 (10)	ND	-	pCi/L
	Sr-90	4	1 (2)	ND	-	pCi/L
	I-131	4	0.5 (2)	ND	-	pCi/L
	Mn-54	4	10 (15)	ND	-	pCi/L
	Fe-59	4	30	ND	-	pCi/L
	Co-58	4	10 (15)	ND	-	pCi/L
	Co-60	4	10 (15)	ND	-	pCi/L
	Zn-65	4	30	ND	-	pCi/L
	Zr-Nb-95	4	15	ND	-	pCi/L
	Cs-134	4	10 (15)	ND	-	pCi/L
	Cs-137	4	10 (18)	ND	-	pCi/L
	Ba-La-140	4	15	ND	-	pCi/L
	Other gamma emitters	4	30	ND	-	pCi/L
Algae	Gross beta	7	0.25	3.61 ± 1.38	5.94 ± 0.25	pCi/g
	Co-58	7	0.25	ND	-	pCi/g
	Co-60	7	0.25	ND	-	pCi/g
	Cs-134	7	0.25	ND	-	pCi/g
	Cs-137	7	0.25	0.010 ± 0.013	0.025 ± 0.010	pCi/g

(a) The indicated LLD is the highest value allowed in the analysis as required by the PBNP REMP. For those analyses where the analytical laboratory can easily obtain a lower LLD, that value is used and the maximum LLD per the PBNP REMP is indicated by parentheses.
(b) "ND" indicates that the sample result is Not Detectable, i.e., sample concentrations were statistically equivalent to zero.

Table 10-1 (continued)
Summary of Radiological Environmental Monitoring Results for 2003

Sample	Description	N	LLD (a)	Average ± Standard Deviation (b)	High ± 2 sigma	Units
Lake Water	Gross beta	47	4	2.9 ± 0.9	5.8 ± 0.8	pCi/L
	I-131	47	0.5 (2)	ND	-	pCi/L
	Mn-54	47	10 (15)	ND	-	pCi/L
	Fe-59	47	30	ND	-	pCi/L
	Co-58	47	10 (15)	ND	-	pCi/L
	Co-60	47	10 (15)	ND	-	pCi/L
	Zn-65	47	30	ND	-	pCi/L
	Zr-Nb-95	47	15	ND	-	pCi/L
	Cs-134	47	10 (15)	ND	-	pCi/L
	Cs-137	47	10 (18)	ND	-	pCi/L
	Ba-La-140	47	15	ND	-	pCi/L
	Ru-103	47	30	ND	-	pCi/L
	Sr-89	16	5 (10)	ND	-	pCi/L
	Sr-90	16	1 (2)	0.58 ± 0.34	1.25 ± 0.47	pCi/L
	H-3	16	500 (3000)	951 ± 1739.0	5712 ± 222	pCi/L
Fish	Gross beta	9	0.5	3.31 ± 0.79	4.17 ± 0.10	pCi/g
	Mn-54	9	0.13	ND	-	pCi/g
	Fe-59	9	0.26	ND	-	pCi/g
	Co-58	9	0.13	ND	-	pCi/g
	Co-60	9	0.13	ND	-	pCi/g
	Zn-65	9	0.26	ND	-	pCi/g
	Cs-134	9	0.13	ND	-	pCi/g
	Cs-137	9	0.15	0.040 ± 0.026	0.066 ± 0.020	pCi/g
	Other gamma emitters	9	0.5	ND	-	pCi/g
Shoreline	Gross beta	10	2	8.9 ± 1.24	10.5 ± 1.34	pCi/g
Sediment	Cs-137	10	0.15	0.024 ± 0.013	0.042 ± 0.018	pCi/g
Soil	Gross beta	16	2	22.51 ± 5.06	31.99 ± 2.26	pCi/g
	Cs-137	16	0.15	0.23 ± 0.15	0.61 ± 0.05	pCi/g
Vegetation	Gross beta	24	0.25	5.73 ± 1.19	8.52 ± 0.30	pCi/g
	I-131	24	0.06	ND	-	pCi/g
	Cs-134	24	0.06	ND	-	pCi/g
	Cs-137	24	0.08	0.006 ± 0.029	0.133 ± 0.046	pCi/g
	Other gamma emitters	24	0.25	ND		pCi/g

(a) The indicated LLD is the highest value allowed in the analysis as required by the PBNP REMP. For those analyses where the analytical laboratory can easily obtain a lower LLD, that value is used and the maximum LLD per the PBNP REMP is indicated by parentheses.

(b) "ND" indicates that the sample result is Not Detectable, i.e., sample concentrations were statistically equal to zero.

Table 10-2
ISFSI Fence TLD Results for 2003

Fence Location	Average ± Standard Deviation
North	2.70 ± 0.24 mR/7 days
East	2.60 ± 0.14 mR/7 days
South	1.50 ± 0.16 mR/7 days
West	6.88 ± 0.37 mR/7 days

11.0 DISCUSSION

11.1 TLD Cards

The ambient radiation was measured in the general area of the site boundary, at an outer ring four – five miles from the plant, at special interest areas, and at one control location, roughly 17 miles Southwest of the plant. The average of the indicator TLD cards is 1.05 mR/7-days and 0.99 mR/7-days at the control location. These results are not significantly different from each other nor from those observed from 1993 through 2002 (tabulated below in Table 11-1). A change in TLD types in 2001 accounts for the increase in average TLD readings seen in 2001 and onward (i.e., prior to third quarter 2001 TLD chips were used versus the TLD cards – see section 9.7.6 for additional information). Therefore, the operation of the plant has had no effect on the ambient gamma radiation.

Table 11-1
Average Indicator TLD Results from 1993 – 2003

Year	Average	±	St. Dev*	Units
1993	0.82	±	0.15	mR/7 days
1994	0.90	±	0.12	mR/7 days
1995	0.87	±	0.13	mR/7 days
1996	0.85	±	0.12	mR/7 days
1997	0.87	±	0.11	mR/7 days
1998	0.79	±	0.13	mR/7 days
1999	0.79	±	0.21	mR/7 days
2000	0.91	±	0.15	mR/7 days
2001	1.06	±	0.19	mR/7 days
2002	1.17	±	0.21	mR/7 days
2003	1.05	±	0.16	mR/7 days

*St. Dev = Standard Deviation

The annual ISFSI fence TLD results listed in Table 11-2 show the anticipated slow trend upward due to the cask additions each year (one added in January; one, December 2002; and one, December 2003). The North and West fence TLDs

continue to record higher doses than the South and East fence TLDs (see Table 11-2) corresponding to the location of the storage units at the NW corner of the site. The overall increase in the West Fence TLD for the ISFSI was about 6% for 2003. All of the indicator sites for the ISFSI (Table 11-3) show decreases within the expected statistical variation. No impact on the ambient gamma radiation at or beyond the site boundary due to the operation of the ISFSI is indicated.

Table 11-2
Average ISFSI Fence TLD Results (mR/7 days)

	Sampling Site			
	North	East	South	West
1995	1.29	1.28	1.10	1.26
1996	2.12	1.39	1.10	1.68
1997	2.05	1.28	1.00	1.66
1998	2.08	1.37	1.02	1.86
1999	2.57	1.84	1.11	3.26
2000	2.72	2.28	1.25	5.05
2001	2.78	2.54	1.36	6.08
2002	2.79	2.74	1.42	6.46
2003	2.70	2.60	1.50	6.88

Table 11-3
Average TLD Results Surrounding the ISFSI (mR/7 days)

	E-03	E-28	E-30	E-31**	E-32**	E-20
Pre-Operation*	0.93	0.87	0.81	0.93	0.98	0.88
1996	0.87	0.78	0.79	0.93	1.00	0.78
1997	0.91	0.89	0.84	0.89	0.97	0.79
1998	0.82	0.68	0.82	0.91	0.85	0.77
1999	0.88	0.83	0.80	0.90	0.99	0.78
2000	0.98	0.88	0.99	0.98	1.06	0.90
2001	1.31	0.95	1.02	1.10	1.04	1.03
2002	1.45	0.91	1.10	1.26	1.25	1.14
2003	1.29	0.82	1.02	1.20	1.15	0.99

*Pre-Operation data is the averages of the years 2/92 through 3/95.
**Sites E-31 and E-32 are located at the Site Boundary to the West and South-West of the ISFSI, respectively.

11.2 Milk

Sr-90 is the only radionuclide consistently present in milk at concentrations statistically above zero. Positive results for Cs-137 occurred in only 2 of the 36 milk samples. Since their injection into the environment due to atmospheric weapons testing during the 1950s - 1980s as well as the Chernobyl accident, Sr-90 and Cs-137 still can be found cycling through the environment because of their 30 year half lives and their chemical properties. These results are common throughout the Great Lakes region and North America. The PBNP 2003 average Sr-90 of 1.1 ± 0.4 pCi/ compares favorably with the averages of 1.0 ± 0.3 to 1.2 ± 0.6 pCi/L obtained since 1997. Because PBNP emitted no Ba-La-140 during 2003, the two positive Ba-La-140 results are false positives. Therefore, the 2003 milk data show no radiological effects of the plant operation.

11.3 Air

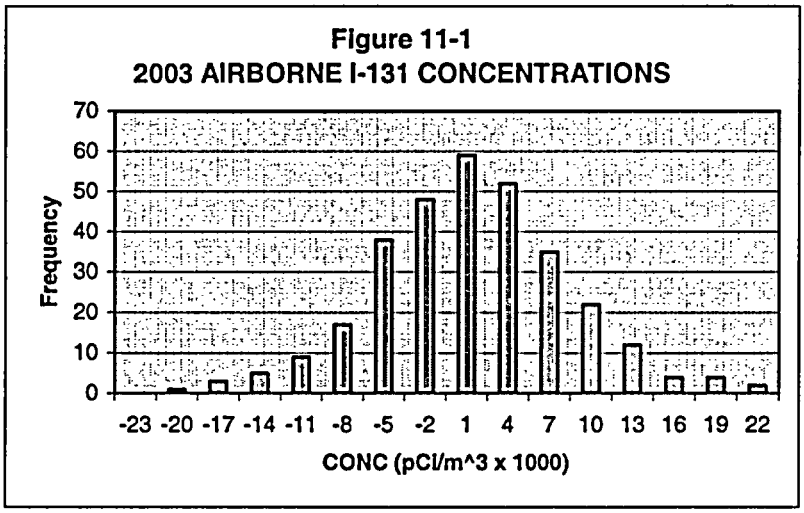
The average annual gross beta concentrations (plus/minus the two-sigma uncertainty) in weekly airborne particulates at the indicator and control locations were 0.023 ± 0.008 pCi/m^3 and 0.025 ± 0.006 pCi/m^3, respectively, and are similar to levels observed from 1993 through 2002 which are tabulated below.

Table 11-4
Average Gross Beta Measurements in Air

Year	Average (pCi/m3)
1993	0.022
1994	0.022
1995	0.021
1996	0.021
1997	0.021
1998	0.022
1999	0.024
2000	0.022
2001	0.023
2002	0.023
2003	0.023

No detectable amounts of airborne I-131 attributable to PBNP were found. Because of the statistical nature of radioactive decay, positive and negative values around zero are expected when there is no I-131 in the samples and all the values are at or near background. The results from the 310 airborne I-131 samples for 2003 are consistent with this distribution. (See Figure 11-1, below.) There were only three I-131 releases from PBNP in 2003. Of the 51 I-131 REMP airborne results which were positive and statistically different from zero, only 2 occurred when there was an actual I-131 release. Therefore, it is concluded that the

positive results are false positives expected due to the statistical nature of radioactive decay and that there was no impact from PBNP during 2003.



In the x-axis scale, the "1" column represents the interval from -1 to +1, the "-5" column, the -7 to -5 interval, etc.

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Neither the indicator nor control locations show results, which on average are significantly different than zero. Again, false positives occur for both Cs-134 and Cs-137. No airborne cesium was emitted from PBNP during 2003. Be-7, a naturally occurring radionuclide, was measured in quarterly composites of all samples with an average of 0.062 pCi/m^3. This is comparable to the average of 0.067 pCi/m^3 at the control site. Naturally occurring radionuclides are not required to be measured by the PBNP REMP, however, quantification of such nuclides serve as a means to monitor the internal consistency of the vendor's analytical program.

In summary, the air data for 2003 demonstrate the operation of PBNP did not have an impact on the surrounding environment.

11.4 Lake Water

For the suite of REMP-specified gamma emitting radionuclides, reported concentrations continue to occur as small negative and positive values scattered around zero, indicating no radiological impact from the operation of PBNP. Sr-90 still persists from radioactive fallout. Tritium, in addition to being produced by water-cooled reactors such as PBNP, also is a naturally occurring radionuclide. During the first quarter of 2003, elevated H-3 concentrations were found in the January-March lake water composite samples. The highest concentration (5712 ± 222 pCi/L) was found 4.2 miles north of PBNP and decreased southward to 4868 ± 208 pCi/L 3.2 miles N of PBNP, to 1121 ± 86 pCi/L 0.5 miles S of PBNP, and

to 668 ± 107 pCi/L 5 miles south of PBNP. The concentration pattern indicates that PBNP was not the source of the observed elevated H-3 concentrations. All other quarterly H-3 composite averages were within the results from previous years: non-detectable to 250 pCi/L.

11.5 Algae

Filamentous algae attached to rocks along the Lake Michigan shoreline are known to concentrate radionuclides from the water with concentration factors over a thousand for certain radionuclides. Typically, the only fission product observed is Cs-137 with averages over years 1995 –2001 of 0.034, 0.050, 0.030, 0.027, 0.031, 0.027, and 0.019; all of which are less than the LLD (0.25 pCi/g). Only two of the 7 samples from 2003 had a Cs-137 concentration statistically higher than zero. The occurrence of Cs-137 in the Lake Michigan environment is attributed to the fallout from the past weapons testing and the Chernobyl accident. Massive resuspension events due to wind stress redistribute Cs-137 throughout Lake Michigan and make the Cs-137 more available to the algae. These events are visible on satellite photographs of the Lake. In 1976 after a Chinese weapons test, Cs-137 concentrations in algae reached 1.2 pCi/g. The concentrations of the naturally occurring radionuclides K-40 and Be-7 in the algae continue to be about 100 times higher than the Cs-137. The algae data indicate no plant effects during 2003.

11.6 Fish

The only specified fission/corrosion radionuclide concentration found in fish which was statistically greater than zero (7 out of 9 samples) continues to be Cs-137 which persists in the Lake Michigan environment from weapons testing fallout in the '50s - '70s and from the Chernobyl accident. The highest Cs-137 value of 0.066 pCi/g is lower than the 0.224 pCi/g found in 2002 and considerably less than the high of 2.8 pCi/g as seen in PBNP samples obtained in the mid-1970s during the Chinese weapons tests. The concentration of naturally occurring K-40 is about 50-100 times higher than the highest Cs-137 concentration. There is no indication of a plant effect.

11.7 Well Water

All of the isotopic well water results are small positive and negative values scattered around zero. The aquifer supplying PBNP water is well below the impermeable blue clay layer which separates the aquifer from surface water. Tritium, the only radionuclide with any possibility of penetrating barrier, is not present. This indicates that PBNP effluents are not getting into the aquifer supplying drinking water to PBNP.

11.8 Soil

Cs-137 from atmospheric weapons testing and the Chernobyl accident fallout continue to be present in soil samples at about 1% of the levels of naturally occurring K-40. As documented in the past, the highest concentrations occur at E-06, Point Beach State Park. These slightly elevated concentrations are attributable to burning of trees which grew during the peak fallout years of the 1960s. Typically, the ashes are dumped on the ground. The Cs-137 is easily leached from the ashes to be bound to the soil and incorporated into the plants as a chemical analog for potassium. This phenomena is documented in the radioecological literature and earlier Annual Monitoring Reports. As seen in the following table the average gross beta result is not significantly different from those values observed in the past. There is no indication of a plant effect.

Table 11-5
Average Gross Beta Concentrations in Soil

Year	Activity (pCi/g)
1993	23.6
1994	19.4
1995	18.0
1996	19.4
1997	22.8
1998	20.0
1999	23.1
2000	22.1
2001	23.5
2002	21.9
2003	22.5

11.9 Shoreline Sediment

Shoreline sediment consists of beach sand and other sediments washed up on the Lake Michigan shore. As in soil samples, the only non-naturally occurring radionuclide found in these samples is Cs-137 and its concentration (pCi/g) is at roughly 1% or less of the naturally occurring concentrations of K-40. The Cs-137 concentrations of the shoreline sediment are about one-tenth of that found in soils. The shoreline sediment data indicate no radiological effects of the plant operation.

11.10 Vegetation

Although the naturally occurring radionuclides Be-7 and K-40 are found in all of the vegetation samples, none of the programmatically specified radionuclides, except Cs-137 are statistically different from zero. As previously documented, the only non-zero Cs-137 concentrations are found at E-06. This is attributable to Cs-137 being released from the ashes of trees growing during the peak fallout years of the 1960s. The Be-7 and K-40 concentrations are about 100 times higher than the Cs-137 concentrations. The sampling data gives no indication of a plant effect.

11.11 Land Use Census

In accordance with the requirements of Section 2.5 of the Environmental Manual, a visual verification of animals grazing in the vicinity of the Point Beach Nuclear Plant site boundary was completed on June 25, 2003, to ensure that the milk sampling locations remain as conservative as practicable. No significant change in the use of pasturelands was noted. Therefore, the existing milk-sampling program continues to be acceptable.

12.0 REMP CONCLUSION

Based on the analytical results from the 813 environmental samples and from 116 sets of TLDs that comprised the PBNP REMP for 2003, PBNP effluents had no discernable, permanent effect on the surrounding environs. These results demonstrate that PBNP continues to have good controls on fuel integrity and on the waste processing. The control of effluents from PBNP continues to be acceptable pursuant to the ALARA criteria of 10 CFR 50.34a.

APPENDIX A

Environmental, Inc. Midwest Laboratory
Final Report for the Pont Beach Nuclear Plant
Reporting Period: January – December 2002

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FINAL REPORT
TO
WISCONSIN ELECTRIC POWER COMPANY
MILWAUKEE, WISCONSIN

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
FOR
THE POINT BEACH NUCLEAR PLANT
TWO RIVERS, WISCONSIN

PREPARED AND SUBMITTED
BY
ENVIRONMENTAL, INC., MIDWEST LABORATORY

Project Number: 8006

Reporting Period: January-December, 2003

Reviewed and
Approved by _____ Date 01-30-2004
B. Grob
Laboratory Manager

Distribution: C. Onesti, WEPCo (1 copy)

POINT BEACH NUCLEAR PLANT

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POINT BEACH NUCLEAR PLANT

1.0 INTRODUCTION

The following constitutes the final 2003 Monthly Progress Report for the Environmental Radiological Monitoring Program conducted at the Point Beach Nuclear Plant, Two Rivers, Wisconsin. Results of analyses are presented in the attached tables. Data tables reflect sample analysis results for both Technical Specification requirements and Special Interest locations and samples are randomly selected within the Program monitoring area to provide additional data for cross-comparisons.

For gamma isotopic analyses, the spectrum covers an energy range from 80 to 2048 KeV. Specifically included are Mn-54, Fe-59, Co-58, Co-60, Zn-65, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Ba-La-140, Cs-134, Cs-137, Ce-141, and Ce-144. Naturally occurring gamma-emitters, such as K-40 and Ra daughters, are frequently detected in soil and sediment samples. Specific isotopes listed are K-40, Tl-208, Pb-212, Bi-214, Ra-226 and Ac-228. Unless noted otherwise, the results reported under "Other Gammas" are for Co-60 and may be higher or lower for other radionuclides.

All concentrations, except gross beta, are decay corrected to the time of collection.

All samples were collected within the scheduled period unless noted otherwise in the Listing of Missed Samples.

POINT BEACH NUCLEAR PLANT

2.0 LISTING OF MISSED SAMPLES

Sample Type	Location	Expected Collection Date	Reason
LW	E-06	01-15-03	Sample not collected due to ice.
AP/AI	E-02	06-18-03	No power to sampler.
SL	E-12	06-06-03	Sample not available.
AP/AI	E-02	08-06-03	No power to sampler.

NOTE: Page 3 is intentionally left out.

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-01, Meteorological Tower
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131	Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030	Required LLD		0.010	0.030
01-08-03	260	0.022 ± 0.003	-0.002 ± 0.006	07-09-03	301	0.022 ± 0.003	0.008 ± 0.005
01-15-03	299	0.019 ± 0.003	0.002 ± 0.006	07-16-03	303	0.013 ± 0.003	-0.006 ± 0.005
01-24-03	393	0.025 ± 0.003	0.000 ± 0.004	07-23-03	303	0.017 ± 0.003	0.006 ± 0.005
01-29-03	213	0.030 ± 0.005	0.004 ± 0.009	07-30-03	299	0.020 ± 0.003	0.009 ± 0.005
02-06-03	346	0.019 ± 0.003	0.004 ± 0.005	08-06-03	315	0.020 ± 0.003	0.002 ± 0.005
02-13-03	301	0.020 ± 0.004	0.001 ± 0.007	08-14-03	339	0.016 ± 0.003	-0.006 ± 0.005
02-20-03	303	0.023 ± 0.004	0.003 ± 0.006	08-20-03	262	0.032 ± 0.004	0.013 ± 0.005
02-26-03	258	0.032 ± 0.004	0.012 ± 0.007	08-27-03	323	0.026 ± 0.003	-0.004 ± 0.004
03-06-03	347	0.032 ± 0.004	0.009 ± 0.005	09-04-03	345	0.017 ± 0.003	0.006 ± 0.005
03-12-03	258	0.037 ± 0.004	0.007 ± 0.006	09-12-03	349	0.039 ± 0.004	0.007 ± 0.005
03-19-03	303	0.030 ± 0.004	-0.003 ± 0.007	09-19-03	299	0.033 ± 0.004	0.003 ± 0.006
03-25-03	256	0.019 ± 0.004	0.004 ± 0.006	09-27-03	348	0.021 ± 0.003	0.002 ± 0.004
04-02-03	325	0.015 ± 0.003	-0.008 ± 0.006				
1st Quarter Mean± s.d.		0.025 ± 0.007	0.003 ± 0.005	3rd Quarter Mean± s.d.		0.023 ± 0.008	0.003 ± 0.006
04-09-03	314	0.023 ± 0.003	-0.005 ± 0.006	10-05-03	340	0.012 ± 0.003	-0.001 ± 0.005
04-16-03	301	0.020 ± 0.003	-0.006 ± 0.006	10-12-03	305	0.032 ± 0.003	0.003 ± 0.005
04-22-03	249	0.019 ± 0.003	-0.006 ± 0.008	10-19-03	303	0.027 ± 0.004	-0.018 ± 0.006
04-29-03	303	0.025 ± 0.004	0.012 ± 0.005	10-25-03	259	0.024 ± 0.004	-0.005 ± 0.007
				10-31-03	259	0.015 ± 0.003	-0.017 ± 0.007
05-07-03	338	0.014 ± 0.002	0.004 ± 0.005				
05-13-03	256	0.012 ± 0.003	0.002 ± 0.008	11-08-03	346	0.019 ± 0.003	-0.002 ± 0.005
05-21-03	344	0.014 ± 0.003	-0.004 ± 0.005	11-14-03	265	0.025 ± 0.004	0.001 ± 0.006
05-27-03	259	0.014 ± 0.004	0.002 ± 0.007	11-20-03	253	0.029 ± 0.004	-0.013 ± 0.007
				11-26-03	258	0.026 ± 0.004	-0.007 ± 0.006
06-05-03	402	0.015 ± 0.002	0.003 ± 0.005	12-02-03	268	0.035 ± 0.004	0.006 ± 0.006
06-11-03	247	0.021 ± 0.004	-0.005 ± 0.007				
06-18-03	302	0.012 ± 0.003	0.000 ± 0.006	12-11-03	396	0.023 ± 0.003	0.004 ± 0.004
06-24-03	259	0.016 ± 0.003	0.001 ± 0.008	12-17-03	276	0.026 ± 0.004	0.001 ± 0.005
07-02-03	348	0.015 ± 0.003	-0.005 ± 0.005	12-23-03	278	0.035 ± 0.004	-0.001 ± 0.006
				12-30-03	325	0.028 ± 0.004	0.009 ± 0.005
2nd Quarter Mean± s.d.		0.017 ± 0.004	-0.001 ± 0.005	4th Quarter Mean± s.d.		0.025 ± 0.007	-0.003 ± 0.008
				Cumulative Average		0.023 ± 0.007	0.001 ± 0.007

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-02, Site Boundary Control Center
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	261	0.025 ± 0.004	-0.006 ± 0.009
01-15-03	299	0.031 ± 0.004	-0.004 ± 0.006
01-24-03	392	0.026 ± 0.003	0.000 ± 0.005
01-29-03	213	0.038 ± 0.005	0.020 ± 0.009
02-06-03	346	0.027 ± 0.003	0.005 ± 0.006
02-13-03	303	0.023 ± 0.004	0.014 ± 0.006
02-20-03	302	0.021 ± 0.003	0.004 ± 0.006
02-26-03	259	0.026 ± 0.004	-0.002 ± 0.007
03-06-03	346	0.035 ± 0.004	-0.005 ± 0.006
03-12-03	259	0.037 ± 0.004	-0.006 ± 0.005
03-19-03	301	0.033 ± 0.004	-0.004 ± 0.006
03-25-03	257	0.018 ± 0.004	-0.007 ± 0.007
04-02-03	326	0.018 ± 0.003	0.002 ± 0.005
1st Quarter Mean± s.d.		0.028 ± 0.007	0.001 ± 0.008
04-09-03	286	0.023 ± 0.003	-0.001 ± 0.007
04-16-03	302	0.024 ± 0.004	0.001 ± 0.006
04-22-03	249	0.019 ± 0.003	0.004 ± 0.008
04-29-03	304	0.018 ± 0.003	-0.007 ± 0.005
05-07-03	353	0.015 ± 0.002	0.003 ± 0.005
05-13-03	254	0.012 ± 0.003	0.002 ± 0.007
05-21-03	343	0.012 ± 0.002	0.003 ± 0.005
05-27-03	259	0.020 ± 0.004	-0.001 ± 0.007
06-04-03	350	0.015 ± 0.003	-0.008 ± 0.005
06-11-03	300	0.015 ± 0.003	-0.001 ± 0.006
06-18-03		NS[a]	
06-24-03	261	0.016 ± 0.003	-0.004 ± 0.007
07-02-03	349	0.018 ± 0.003	-0.016 ± 0.005
2nd Quarter Mean± s.d.		0.017 ± 0.004	-0.002 ± 0.006
07-09-03	300	0.023 ± 0.003	-0.003 ± 0.005
07-16-03	303	0.017 ± 0.003	0.000 ± 0.006
07-23-03	303	0.017 ± 0.003	-0.012 ± 0.006
07-30-03	302	0.023 ± 0.003	0.001 ± 0.005
08-06-03		NS[a]	
08-13-03	295	0.015 ± 0.003	-0.006 ± 0.006
08-20-03	294	0.030 ± 0.004	0.010 ± 0.005
08-27-03	302	0.035 ± 0.004	0.011 ± 0.005
09-04-03	345	0.018 ± 0.003	0.001 ± 0.004
09-12-03	349	0.035 ± 0.004	0.001 ± 0.004
09-19-03	299	0.038 ± 0.004	-0.004 ± 0.006
09-27-03	348	0.020 ± 0.003	0.007 ± 0.004
3rd Quarter Mean± s.d.		0.025 ± 0.008	0.001 ± 0.007
10-05-03	340	0.013 ± 0.003	-0.003 ± 0.005
10-12-03	305	0.038 ± 0.004	0.013 ± 0.006
10-19-03	303	0.027 ± 0.004	0.008 ± 0.006
10-25-03	259	0.022 ± 0.004	0.001 ± 0.007
10-31-03	258	0.016 ± 0.003	0.002 ± 0.006
11-08-03	346	0.022 ± 0.003	0.014 ± 0.005
11-14-03	265	0.028 ± 0.004	0.001 ± 0.006
11-20-03	254	0.029 ± 0.004	-0.009 ± 0.006
11-26-03	259	0.027 ± 0.004	0.006 ± 0.006
12-02-03	267	0.034 ± 0.004	0.000 ± 0.007
12-11-03	383	0.022 ± 0.003	0.009 ± 0.003
12-17-03	258	0.027 ± 0.004	0.001 ± 0.005
12-23-03	260	0.035 ± 0.005	-0.006 ± 0.006
12-30-03	304	0.027 ± 0.004	0.007 ± 0.006
4th Quarter Mean± s.d.		0.026 ± 0.007	0.003 ± 0.007
Cumulative Average		0.024 ± 0.008	0.001 ± 0.007

[a] "NS" = No sample; See Table 2.0, Listing of Missed Samples.

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-03, West Boundary
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	260	0.021 ± 0.003	-0.006 ± 0.006
01-15-03	299	0.021 ± 0.004	-0.004 ± 0.006
01-24-03	391	0.030 ± 0.003	0.000 ± 0.004
01-29-03	215	0.042 ± 0.005	0.019 ± 0.008
02-06-03	346	0.031 ± 0.003	0.011 ± 0.005
02-13-03	302	0.021 ± 0.004	0.003 ± 0.006
02-20-03	303	0.025 ± 0.004	0.010 ± 0.005
02-26-03	258	0.029 ± 0.004	0.007 ± 0.007
03-06-03	347	0.032 ± 0.004	-0.007 ± 0.005
03-12-03	207	0.045 ± 0.005	-0.006 ± 0.008
03-19-03	292	0.030 ± 0.004	-0.003 ± 0.006
03-25-03	256	0.020 ± 0.004	-0.001 ± 0.007
04-02-03	334	0.017 ± 0.003	0.003 ± 0.005
1st Quarter Mean± s.d.		0.028 ± 0.008	0.002 ± 0.008
04-09-03	298	0.023 ± 0.003	-0.006 ± 0.006
04-16-03	305	0.019 ± 0.003	-0.002 ± 0.006
04-22-03	256	0.019 ± 0.003	0.002 ± 0.007
04-29-03	227	0.026 ± 0.004	-0.002 ± 0.007
05-07-03	353	0.013 ± 0.002	0.000 ± 0.004
05-13-03	254	0.011 ± 0.003	0.009 ± 0.006
05-21-03	343	0.012 ± 0.002	-0.002 ± 0.006
05-27-03	259	0.021 ± 0.004	0.002 ± 0.007
06-04-03	350	0.014 ± 0.003	0.001 ± 0.005
06-11-03	300	0.016 ± 0.003	0.000 ± 0.007
06-18-03	302	0.015 ± 0.003	0.005 ± 0.006
06-24-03	259	0.018 ± 0.003	-0.001 ± 0.007
07-02-03	349	0.016 ± 0.003	-0.016 ± 0.006
2nd Quarter Mean± s.d.		0.017 ± 0.004	-0.001 ± 0.006
07-09-03	302	0.023 ± 0.003	-0.001 ± 0.005
07-16-03	300	0.013 ± 0.003	-0.005 ± 0.006
07-23-03	305	0.017 ± 0.003	-0.006 ± 0.006
07-30-03	301	0.022 ± 0.003	-0.005 ± 0.005
08-06-03	304	0.021 ± 0.004	0.001 ± 0.005
08-13-03	309	0.014 ± 0.003	0.004 ± 0.005
08-20-03	301	0.028 ± 0.003	0.004 ± 0.005
08-27-03	295	0.031 ± 0.004	0.007 ± 0.005
09-04-03	344	0.018 ± 0.003	0.017 ± 0.004
09-12-03	349	0.032 ± 0.004	-0.002 ± 0.004
09-19-03	299	0.032 ± 0.004	0.013 ± 0.005
09-27-03	349	0.019 ± 0.003	-0.002 ± 0.005
3rd Quarter Mean± s.d.		0.023 ± 0.007	0.002 ± 0.007
10-05-03	340	0.010 ± 0.003	0.001 ± 0.005
10-12-03	305	0.034 ± 0.004	0.007 ± 0.006
10-19-03	303	0.020 ± 0.003	-0.008 ± 0.005
10-25-03	260	0.022 ± 0.004	-0.016 ± 0.007
10-31-03	258	0.016 ± 0.003	0.001 ± 0.006
11-08-03	356	0.019 ± 0.003	0.003 ± 0.005
11-14-03	256	0.024 ± 0.004	-0.003 ± 0.007
11-20-03	253	0.031 ± 0.004	0.001 ± 0.007
11-26-03	239	0.030 ± 0.004	-0.013 ± 0.007
12-02-03	266	0.030 ± 0.004	-0.021 ± 0.006
12-11-03	385	0.020 ± 0.003	0.007 ± 0.003
12-17-03	258	0.024 ± 0.004	-0.002 ± 0.006
12-23-03	260	0.033 ± 0.005	0.001 ± 0.006
12-30-03	303	0.027 ± 0.004	0.018 ± 0.005
4th Quarter Mean± s.d.		0.024 ± 0.007	-0.002 ± 0.010
Cumulative Average		0.023 ± 0.008	0.000 ± 0.008

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-04, North Boundary
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	251	0.023 ± 0.004	-0.004 ± 0.008
01-15-03	289	0.020 ± 0.004	0.005 ± 0.006
01-24-03	384	0.021 ± 0.003	-0.002 ± 0.005
01-29-03	208	0.030 ± 0.005	-0.005 ± 0.009
02-06-03	340	0.028 ± 0.003	-0.014 ± 0.005
02-13-03	301	0.019 ± 0.003	-0.002 ± 0.006
02-20-03	303	0.019 ± 0.003	0.005 ± 0.006
02-26-03	259	0.028 ± 0.004	-0.003 ± 0.006
03-06-03	346	0.034 ± 0.004	-0.001 ± 0.005
03-12-03	258	0.036 ± 0.004	-0.017 ± 0.006
03-19-03	301	0.029 ± 0.004	-0.010 ± 0.006
03-25-03	265	0.017 ± 0.004	0.001 ± 0.007
04-02-03	346	0.014 ± 0.003	0.011 ± 0.005
1st Quarter Mean± s.d.		0.024 ± 0.007	-0.003 ± 0.008
04-09-03	297	0.020 ± 0.003	0.001 ± 0.006
04-16-03	305	0.018 ± 0.003	0.009 ± 0.005
04-22-03	257	0.020 ± 0.003	-0.009 ± 0.007
04-29-03	293	0.017 ± 0.003	-0.011 ± 0.005
05-07-03	329	0.013 ± 0.002	-0.002 ± 0.006
05-13-03	254	0.012 ± 0.003	0.001 ± 0.008
05-21-03	343	0.011 ± 0.002	-0.008 ± 0.005
05-27-03	259	0.016 ± 0.004	0.005 ± 0.007
06-04-03	350	0.011 ± 0.002	0.002 ± 0.006
06-11-03	300	0.017 ± 0.003	0.002 ± 0.005
06-18-03	302	0.012 ± 0.003	-0.010 ± 0.006
06-24-03	259	0.015 ± 0.003	0.010 ± 0.007
07-02-03	349	0.016 ± 0.003	-0.003 ± 0.006
2nd Quarter Mean± s.d.		0.015 ± 0.003	-0.001 ± 0.007

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
07-09-03	302	0.023 ± 0.003	0.006 ± 0.005
07-16-03	298	0.010 ± 0.003	-0.011 ± 0.006
07-23-03	307	0.016 ± 0.003	0.002 ± 0.006
07-30-03	300	0.021 ± 0.003	-0.001 ± 0.005
08-06-03	304	0.019 ± 0.003	0.009 ± 0.006
08-13-03	309	0.015 ± 0.003	0.004 ± 0.005
08-20-03	300	0.030 ± 0.004	0.002 ± 0.005
08-27-03	296	0.032 ± 0.004	-0.014 ± 0.005
09-04-03	344	0.019 ± 0.003	0.001 ± 0.004
09-12-03	349	0.038 ± 0.004	-0.004 ± 0.005
09-19-03	299	0.031 ± 0.003	-0.002 ± 0.006
09-27-03	348	0.018 ± 0.003	0.007 ± 0.004
3rd Quarter Mean± s.d.		0.023 ± 0.008	0.000 ± 0.007
10-05-03	341	0.010 ± 0.003	0.001 ± 0.005
10-12-03	305	0.032 ± 0.003	0.002 ± 0.005
10-19-03	303	0.026 ± 0.004	0.006 ± 0.005
10-25-03	260	0.025 ± 0.004	-0.002 ± 0.006
10-31-03	258	0.016 ± 0.003	0.000 ± 0.006
11-08-03	356	0.018 ± 0.003	-0.008 ± 0.005
11-14-03	256	0.024 ± 0.004	0.015 ± 0.005
11-20-03	254	0.033 ± 0.004	-0.006 ± 0.007
11-26-03	259	0.026 ± 0.004	0.007 ± 0.006
12-02-03	265	0.034 ± 0.004	-0.006 ± 0.006
12-11-03	386	0.021 ± 0.003	-0.006 ± 0.004
12-17-03	258	0.030 ± 0.005	0.011 ± 0.005
12-23-03	260	0.034 ± 0.005	0.002 ± 0.006
12-30-03	303	0.033 ± 0.004	-0.001 ± 0.006
4th Quarter Mean± s.d.		0.026 ± 0.007	0.001 ± 0.007
Cumulative Average		0.022 ± 0.008	-0.001 ± 0.007

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-04, North Boundary
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	251	0.023 ± 0.004	-0.004 ± 0.008
01-15-03	289	0.020 ± 0.004	0.005 ± 0.006
01-24-03	384	0.021 ± 0.003	-0.002 ± 0.005
01-29-03	208	0.030 ± 0.005	-0.005 ± 0.009
02-06-03	340	0.028 ± 0.003	-0.014 ± 0.005
02-13-03	301	0.019 ± 0.003	-0.002 ± 0.006
02-20-03	303	0.019 ± 0.003	0.005 ± 0.006
02-26-03	259	0.028 ± 0.004	-0.003 ± 0.006
03-06-03	346	0.034 ± 0.004	-0.001 ± 0.005
03-12-03	258	0.036 ± 0.004	-0.017 ± 0.006
03-19-03	301	0.029 ± 0.004	-0.010 ± 0.006
03-25-03	265	0.017 ± 0.004	0.001 ± 0.007
04-02-03	346	0.014 ± 0.003	0.011 ± 0.005
1st Quarter Mean± s.d.		0.024 ± 0.007	-0.003 ± 0.008
04-09-03	297	0.020 ± 0.003	0.001 ± 0.006
04-16-03	305	0.018 ± 0.003	0.009 ± 0.005
04-22-03	257	0.020 ± 0.003	-0.009 ± 0.007
04-29-03	293	0.017 ± 0.003	-0.011 ± 0.005
05-07-03	329	0.013 ± 0.002	-0.002 ± 0.006
05-13-03	254	0.012 ± 0.003	0.001 ± 0.008
05-21-03	343	0.011 ± 0.002	-0.008 ± 0.005
05-27-03	259	0.016 ± 0.004	0.005 ± 0.007
06-04-03	350	0.011 ± 0.002	0.002 ± 0.006
06-11-03	300	0.017 ± 0.003	0.002 ± 0.005
06-18-03	302	0.012 ± 0.003	-0.010 ± 0.006
06-24-03	259	0.015 ± 0.003	0.010 ± 0.007
07-02-03	349	0.016 ± 0.003	-0.003 ± 0.006
2nd Quarter Mean± s.d.		0.015 ± 0.003	-0.001 ± 0.007

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
07-09-03	302	0.023 ± 0.003	0.006 ± 0.005
07-16-03	298	0.010 ± 0.003	-0.011 ± 0.006
07-23-03	307	0.016 ± 0.003	0.002 ± 0.006
07-30-03	300	0.021 ± 0.003	-0.001 ± 0.005
08-06-03	304	0.019 ± 0.003	0.009 ± 0.006
08-13-03	309	0.015 ± 0.003	0.004 ± 0.005
08-20-03	300	0.030 ± 0.004	0.002 ± 0.005
08-27-03	296	0.032 ± 0.004	-0.014 ± 0.005
09-04-03	344	0.019 ± 0.003	0.001 ± 0.004
09-12-03	349	0.038 ± 0.004	-0.004 ± 0.005
09-19-03	299	0.031 ± 0.003	-0.002 ± 0.006
09-27-03	348	0.018 ± 0.003	0.007 ± 0.004
3rd Quarter Mean± s.d.		0.023 ± 0.008	0.000 ± 0.007
10-05-03	341	0.010 ± 0.003	0.001 ± 0.005
10-12-03	305	0.032 ± 0.003	0.002 ± 0.005
10-19-03	303	0.026 ± 0.004	0.006 ± 0.005
10-25-03	260	0.025 ± 0.004	-0.002 ± 0.006
10-31-03	258	0.016 ± 0.003	0.000 ± 0.006
11-08-03	356	0.018 ± 0.003	-0.008 ± 0.005
11-14-03	256	0.024 ± 0.004	0.015 ± 0.005
11-20-03	254	0.033 ± 0.004	-0.006 ± 0.007
11-26-03	259	0.026 ± 0.004	0.007 ± 0.006
12-02-03	265	0.034 ± 0.004	-0.006 ± 0.006
12-11-03	386	0.021 ± 0.003	-0.006 ± 0.004
12-17-03	258	0.030 ± 0.005	0.011 ± 0.005
12-23-03	260	0.034 ± 0.005	0.002 ± 0.006
12-30-03	303	0.033 ± 0.004	-0.001 ± 0.006
4th Quarter Mean± s.d.		0.026 ± 0.007	0.001 ± 0.007
Cumulative Average		0.022 ± 0.008	-0.001 ± 0.007

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-08, G.J. Francar Residence
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	251	0.025 ± 0.004	-0.001 ± 0.006
01-15-03	281	0.023 ± 0.004	-0.007 ± 0.007
01-24-03	374	0.024 ± 0.003	-0.003 ± 0.003
01-29-03	217	0.036 ± 0.005	0.004 ± 0.008
02-06-03	346	0.024 ± 0.003	0.011 ± 0.005
02-13-03	302	0.022 ± 0.004	0.001 ± 0.006
02-20-03	303	0.021 ± 0.003	-0.001 ± 0.006
02-26-03	258	0.028 ± 0.004	0.002 ± 0.007
03-06-03	348	0.033 ± 0.004	0.006 ± 0.006
03-12-03	257	0.041 ± 0.005	0.003 ± 0.006
03-19-03	302	0.032 ± 0.004	-0.010 ± 0.007
03-25-03	258	0.018 ± 0.004	0.005 ± 0.008
04-02-03	352	0.017 ± 0.003	0.008 ± 0.005
1st Quarter Mean± s.d.		0.026 ± 0.007	0.001 ± 0.006
04-09-03	302	0.022 ± 0.003	-0.006 ± 0.006
04-16-03	301	0.022 ± 0.004	0.004 ± 0.006
04-22-03	256	0.017 ± 0.003	0.007 ± 0.007
04-29-03	303	0.020 ± 0.003	0.005 ± 0.005
05-07-03	355	0.013 ± 0.002	0.003 ± 0.006
05-13-03	258	0.010 ± 0.003	-0.007 ± 0.006
05-21-03	343	0.010 ± 0.002	0.000 ± 0.004
05-27-03	258	0.017 ± 0.004	0.002 ± 0.006
06-04-03	352	0.014 ± 0.002	-0.002 ± 0.005
06-11-03	303	0.016 ± 0.003	-0.002 ± 0.006
06-18-03	298	0.012 ± 0.003	-0.004 ± 0.006
06-24-03	258	0.016 ± 0.003	0.009 ± 0.006
07-02-03	349	0.017 ± 0.003	-0.008 ± 0.005
2nd Quarter Mean± s.d.		0.015 ± 0.004	0.001 ± 0.005
07-09-03	303	0.022 ± 0.003	0.012 ± 0.006
07-16-03	300	0.011 ± 0.003	0.008 ± 0.006
07-23-03	302	0.016 ± 0.003	-0.007 ± 0.006
07-30-03	297	0.021 ± 0.003	-0.013 ± 0.006
08-06-03	306	0.018 ± 0.003	0.004 ± 0.006
08-13-03	287	0.012 ± 0.003	0.012 ± 0.006
08-20-03	277	0.026 ± 0.004	0.002 ± 0.005
08-27-03	301	0.033 ± 0.004	0.003 ± 0.005
09-04-03	344	0.019 ± 0.003	0.006 ± 0.005
09-12-03	352	0.038 ± 0.004	0.001 ± 0.004
09-19-03	297	0.030 ± 0.003	-0.008 ± 0.005
09-27-03	348	0.021 ± 0.003	-0.003 ± 0.004
3rd Quarter Mean± s.d.		0.022 ± 0.008	0.001 ± 0.008
10-05-03	341	0.008 ± 0.002	-0.003 ± 0.004
10-12-03	306	0.034 ± 0.004	-0.005 ± 0.006
10-19-03	302	0.023 ± 0.003	-0.002 ± 0.005
10-25-03	260	0.022 ± 0.004	0.021 ± 0.007
10-31-03	257	0.015 ± 0.003	0.001 ± 0.006
11-08-03	350	0.022 ± 0.003	0.003 ± 0.005
11-14-03	262	0.026 ± 0.004	-0.006 ± 0.005
11-20-03	255	0.032 ± 0.004	0.010 ± 0.006
11-26-03	258	0.025 ± 0.004	0.001 ± 0.007
12-02-03	263	0.030 ± 0.004	-0.007 ± 0.007
12-11-03	388	0.027 ± 0.003	0.010 ± 0.004
12-17-03	261	0.025 ± 0.004	0.005 ± 0.006
12-23-03	256	0.030 ± 0.005	0.010 ± 0.006
12-30-03	301	0.030 ± 0.004	-0.008 ± 0.005
4th Quarter Mean± s.d.		0.026 ± 0.005	0.003 ± 0.009
Cumulative Average		0.023 ± 0.008	0.001 ± 0.007

POINT BEACH NUCLEAR PLANT

Airborne particulates and charcoal canisters, analyses for gross beta and iodine-131.
Location: E-20, Silver Lake
Units: pCi/m^3
Collection: Continuous, weekly exchange.

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
01-08-03	248	0.024 ± 0.004	-0.002 ± 0.006
01-15-03	283	0.052 ± 0.005	-0.002 ± 0.007
01-24-03	362	0.027 ± 0.003	-0.008 ± 0.004
01-29-03	206	0.041 ± 0.006	0.009 ± 0.009
02-06-03	336	0.024 ± 0.003	-0.001 ± 0.005
02-13-03	283	0.020 ± 0.004	0.006 ± 0.006
02-20-03	295	0.021 ± 0.003	0.001 ± 0.007
02-26-03	261	0.028 ± 0.004	0.004 ± 0.006
03-06-03	346	0.032 ± 0.004	0.004 ± 0.004
03-12-03	250	0.049 ± 0.005	0.006 ± 0.005
03-19-03	283	0.033 ± 0.004	0.000 ± 0.007
03-25-03	243	0.022 ± 0.004	0.001 ± 0.008
04-02-03	341	0.017 ± 0.003	0.003 ± 0.005
1st Quarter Mean± s.d.		0.030 ± 0.011	0.002 ± 0.004
04-09-03	300	0.024 ± 0.003	0.010 ± 0.006
04-16-03	296	0.020 ± 0.003	0.014 ± 0.006
04-22-03	240	0.023 ± 0.004	0.005 ± 0.008
04-29-03	284	0.020 ± 0.004	-0.013 ± 0.006
05-07-03	333	0.016 ± 0.003	0.001 ± 0.005
05-13-03	242	0.010 ± 0.003	0.017 ± 0.007
05-21-03	319	0.013 ± 0.003	-0.005 ± 0.006
05-27-03	243	0.018 ± 0.004	-0.003 ± 0.007
06-04-03	330	0.015 ± 0.003	-0.006 ± 0.005
06-11-03	284	0.017 ± 0.003	-0.010 ± 0.006
06-18-03	282	0.013 ± 0.003	-0.003 ± 0.006
06-24-03	241	0.020 ± 0.003	0.000 ± 0.008
07-02-03	329	0.019 ± 0.003	-0.003 ± 0.006
2nd Quarter Mean± s.d.		0.018 ± 0.004	0.000 ± 0.009

Date Collected	Vol. (m^3)	Gross Beta	I-131
Required LLD		0.010	0.030
07-09-03	286	0.022 ± 0.003	0.007 ± 0.007
07-16-03	283	0.015 ± 0.003	0.001 ± 0.005
07-23-03	287	0.017 ± 0.003	0.003 ± 0.005
07-30-03	283	0.026 ± 0.003	-0.006 ± 0.005
08-06-03	284	0.025 ± 0.004	0.003 ± 0.005
08-13-03	285	0.015 ± 0.003	-0.004 ± 0.007
08-20-03	279	0.027 ± 0.004	0.002 ± 0.005
08-27-03	285	0.034 ± 0.004	0.005 ± 0.005
09-03-03	283	0.021 ± 0.003	0.008 ± 0.005
09-12-03	368	0.039 ± 0.004	-0.009 ± 0.005
09-19-03	279	0.037 ± 0.004	-0.005 ± 0.006
09-27-03	326	0.024 ± 0.003	0.001 ± 0.005
3rd Quarter Mean± s.d.		0.025 ± 0.008	0.001 ± 0.005
10-05-03	321	0.015 ± 0.003	0.011 ± 0.005
10-12-03	288	0.040 ± 0.004	-0.003 ± 0.007
10-19-03	301	0.027 ± 0.004	0.002 ± 0.006
10-25-03	265	0.025 ± 0.004	0.010 ± 0.006
10-31-03	254	0.014 ± 0.003	-0.002 ± 0.007
11-08-03	346	0.019 ± 0.003	-0.004 ± 0.005
11-14-03	266	0.024 ± 0.004	-0.003 ± 0.006
11-20-03	247	0.026 ± 0.004	0.005 ± 0.006
11-26-03	244	0.029 ± 0.004	-0.009 ± 0.008
12-02-03	236	0.034 ± 0.005	0.006 ± 0.007
12-11-03	382	0.024 ± 0.003	0.005 ± 0.003
12-17-03	259	0.029 ± 0.005	0.007 ± 0.005
12-23-03	257	0.035 ± 0.005	0.008 ± 0.006
12-30-03	301	0.027 ± 0.004	-0.007 ± 0.006
4th Quarter Mean± s.d.		0.026 ± 0.007	0.002 ± 0.006
Cumulative Average		0.025 ± 0.009	0.001 ± 0.006

POINT BEACH NUCLEAR PLANT

GAMMA EMITTERS IN QUARTERLY COMPOSITES OF

AIR PARTICULATE FILTERS

(Concentration pCi/m^3)

Location	Lab Code Req. LLD	Be-7 -	Cs-134 (0.05)	Cs-137 (0.06)	Other Gammas[a] (0.10)	Volume
			1st Quarter			
E-01	EAP- 1962	0.070 ± 0.015	-0.0003 ± 0.0004	0.0003 ± 0.0004	0.0003 ± 0.0005	3862
E-02	- 1963	0.059 ± 0.013	0.0002 ± 0.0005	-0.0004 ± 0.0007	0.0003 ± 0.0006	3864
E-03	- 1964	0.075 ± 0.014	0.0003 ± 0.0005	0.0002 ± 0.0005	0.0004 ± 0.0005	3810
E-04	- 1965	0.055 ± 0.013	0.0002 ± 0.0005	0.0006 ± 0.0005	-0.0001 ± 0.0005	3851
E-08	- 1966	0.067 ± 0.016	0.0005 ± 0.0005	-0.0006 ± 0.0006	0.0003 ± 0.0008	3849
E-20	- 1967	0.081 ± 0.018	0.0003 ± 0.0006	0.0002 ± 0.0011	0.0014 ± 0.0009	3737
			2nd Quarter			
E-01	EAP- 3937	0.075 ± 0.013	-0.0002 ± 0.0005	0.0003 ± 0.0004	0.0003 ± 0.0007	3922
E-02	- 3938	0.075 ± 0.016	-0.0001 ± 0.0006	0.0003 ± 0.0005	0.0001 ± 0.0006	3610
E-03	- 3939	0.072 ± 0.014	0.0004 ± 0.0005	-0.0001 ± 0.0006	0.0001 ± 0.0004	3855
E-04	- 3940	0.071 ± 0.013	0.0010 ± 0.0005	-0.0002 ± 0.0006	0.0001 ± 0.0007	3897
E-08	- 3941	0.073 ± 0.015	0.0001 ± 0.0006	-0.0002 ± 0.0005	-0.0001 ± 0.0006	3936
E-20	- 3942	0.073 ± 0.013	0.0009 ± 0.0006	0.0001 ± 0.0006	0.0003 ± 0.0008	3723
E-01	EAP- 6167	0.066 ± 0.015	0.0006 ± 0.0005	-0.0001 ± 0.0006	0.0004 ± 0.0007	3786
E-02	- 6168	0.079 ± 0.021	0.0004 ± 0.0008	-0.0007 ± 0.0007	0.0005 ± 0.0008	3440
E-03	- 6169	0.075 ± 0.018	-0.0001 ± 0.0006	-0.0001 ± 0.0007	-0.0004 ± 0.0006	3758
E-04	- 6170	0.076 ± 0.020	-0.0002 ± 0.0005	0.0001 ± 0.0005	-0.0001 ± 0.0007	3756
E-08	- 6171	0.058 ± 0.018	-0.0010 ± 0.0007	-0.0001 ± 0.0006	0.0005 ± 0.0009	3714
E-20	- 6172	0.066 ± 0.018	-0.0002 ± 0.0007	0.0003 ± 0.0006	-0.0001 ± 0.0007	3528
E-01	EAP- 7952,3	0.039 ± 0.008	0.0002 ± 0.0005	0.0002 ± 0.0005	-0.0003 ± 0.0006	4131
E-02	- 7954	0.043 ± 0.013	0.0001 ± 0.0006	-0.0003 ± 0.0005	-0.0001 ± 0.0005	4061
E-03	- 7955	0.043 ± 0.011	0.0003 ± 0.0006	0.0001 ± 0.0005	-0.0002 ± 0.0006	4042
E-04	- 7956	0.042 ± 0.012	0.0002 ± 0.0006	-0.0004 ± 0.0005	-0.0001 ± 0.0006	4064
E-08	- 7957	0.035 ± 0.011	0.0006 ± 0.0005	0.0005 ± 0.0006	-0.0004 ± 0.0008	4060
E-20	- 7958	0.047 ± 0.015	-0.0002 ± 0.0005	0.0002 ± 0.0005	0.0005 ± 0.0004	3967

[a] See Introduction

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-11 Funk Dairy Farm

Collection Date	01-08-03	02-05-03	03-05-03	Required LLD
Lab Code	EMI-119,20	EMI-484	EMI-926	
Sr-89	-0.2 ± 1.0	0.3 ± 0.9	0.1 ± 0.8	5.0
Sr-90	2.1 ± 0.3	0.8 ± 0.4	1.0 ± 0.3	1.0
I-131	-0.02 ± 0.21	-0.06 ± 0.10	0.02 ± 0.16	0.5
K-40	1293 ± 80	1493 ± 114	1431 ± 108	
Cs-134	-1.7 ± 2.3	0.6 ± 2.2	-0.8 ± 2.6	5.0
Cs-137	-1.2 ± 2.3	2.9 ± 2.2	0.7 ± 2.3	5.0
Ba-La-140	1.1 ± 2.0	-0.2 ± 2.4	-1.3 ± 1.7	5.0
Other Gammas[a]	-0.4 ± 2.4	-0.3 ± 2.5	0.6 ± 2.6	15.0

Collection Date	04-02-03	05-07-03	06-04-03	Required LLD
Lab Code	EMI-1437	EMI-2301	EMI-2942	
Sr-89	-0.1 ± 0.8	0.6 ± 0.7	1.1 ± 1.1	5.0
Sr-90	1.0 ± 0.4	1.3 ± 0.4	0.8 ± 0.5	1.0
I-131	-0.03 ± 0.15	-0.15 ± 0.18	0.09 ± 0.16	0.5
K-40	1328 ± 110	1314 ± 106	1397 ± 123	
Cs-134	0.5 ± 2.2	-1.9 ± 2.0	-0.5 ± 2.5	5.0
Cs-137	1.1 ± 2.1	1.0 ± 1.9	-0.9 ± 2.5	5.0
Ba-La-140	0.5 ± 1.8	-1.1 ± 1.9	1.9 ± 2.0	5.0
Other Gammas[a]	2.6 ± 2.2	-1.2 ± 2.3	-1.3 ± 2.1	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-11 Funk Dairy Farm

Collection Date	07-02-03	08-06-03	09-03-03	Required LLD
Lab Code	EMI-3607	EMI-4480	EMI-4963	
Sr-89	-0.2 ± 1.1	0.6 ± 0.9	0.1 ± 1.1	5.0
Sr-90	1.9 ± 0.4	0.8 ± 0.3	0.9 ± 0.4	1.0
I-131	0.07 ± 0.18	0.12 ± 0.15	-0.15 ± 0.13	0.5
K-40	1364 ± 118	1309 ± 116	1446 ± 112	
Cs-134	1.2 ± 2.2	1.6 ± 2.3	-1.0 ± 2.2	5.0
Cs-137	-0.3 ± 2.3	0.1 ± 2.2	1.0 ± 1.8	5.0
Ba-La-140	1.8 ± 1.5	0.2 ± 1.5	1.8 ± 1.4	5.0
Other Gammas[a]	-1.1 ± 1.9	-1.4 ± 2.6	-1.2 ± 2.0	15.0

Collection Date	10-08-03	11-05-03	12-03-03	Required LLD
Lab Code	EMI-5836	EMI-6655	EMI-7228	
Sr-89	-0.1 ± 0.7	-0.2 ± 0.8	0.6 ± 0.8	5.0
Sr-90	1.0 ± 0.3	0.8 ± 0.3	0.8 ± 0.3	1.0
I-131	-0.17 ± 0.16	0.12 ± 0.13	0.11 ± 0.17	0.5
K-40	1363 ± 124	1417 ± 114	1418 ± 118	
Cs-134	2.1 ± 2.5	-2.8 ± 2.7	0.2 ± 2.3	5.0
Cs-137	-0.2 ± 2.3	1.6 ± 2.2	-0.8 ± 2.9	5.0
Ba-La-140	-1.3 ± 1.8	-0.6 ± 2.3	-2.4 ± 2.6	5.0
Other Gammas[a]	-0.3 ± 2.7	0.4 ± 2.2	-1.6 ± 2.4	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-19 Engelbrecht Dairy

Collection Date	01-08-03	02-05-03	03-05-03	Required LLD
Lab Code	EMI-121	EMI-485	EMI-927	
Sr-89	-2.5 ± 1.4	0.3 ± 1.0	-0.2 ± 0.8	5.0
Sr-90	1.3 ± 0.6	0.8 ± 0.4	0.9 ± 0.3	1.0
I-131	0.10 ± 0.19	-0.13 ± 0.09	0.10 ± 0.17	0.5
K-40	1270 ± 121	1380 ± 113	1480 ± 115	
Cs-134	0.7 ± 2.3	-1.7 ± 2.6	-0.9 ± 2.5	5.0
Cs-137	0.6 ± 2.2	-0.1 ± 2.3	1.1 ± 2.3	5.0
Ba-La-140	-2.2 ± 1.9	-2.0 ± 1.8	-0.3 ± 2.4	5.0
Other Gammas[a]	1.6 ± 2.3	1.5 ± 2.2	0.3 ± 2.3	15.0

Collection Date	04-02-03	05-07-03	06-04-03	Required LLD
Lab Code	EMI-1438	EMI-2302	EMI-2943	
Sr-89	0.3 ± 0.9	-0.1 ± 0.9	-0.4 ± 0.8	5.0
Sr-90	0.8 ± 0.4	1.1 ± 0.4	0.9 ± 0.3	1.0
I-131	0.07 ± 0.16	-0.04 ± 0.19	-0.04 ± 0.17	0.5
K-40	1356 ± 113	1386 ± 124	1277 ± 113	
Cs-134	1.6 ± 2.2	0.9 ± 2.2	-0.6 ± 2.2	5.0
Cs-137	-0.5 ± 2.3	-0.5 ± 2.3	0.7 ± 2.4	5.0
Ba-La-140	-1.2 ± 1.6	-0.6 ± 2.4	-1.7 ± 2.2	5.0
Other Gammas[a]	-1.0 ± 2.5	0.2 ± 2.4	0.8 ± 2.2	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-19 Engelbrecht Dairy

Collection Date	07-02-03	08-06-03	09-03-03	Required LLD
Lab Code	EMI-3608	EMI-4481	EMI-4964	
Sr-89	-0.8 ± 1.0	-0.4 ± 1.0	0.9 ± 1.2	5.0
Sr-90	1.5 ± 0.4	1.1 ± 0.3	1.1 ± 0.4	1.0
I-131	0.09 ± 0.21	0.05 ± 0.14	-0.10 ± 0.18	0.5
K-40	1451 ± 109	1345 ± 112	1436 ± 118	
Cs-134	-3.0 ± 2.1	1.2 ± 2.3	-1.5 ± 2.0	5.0
Cs-137	1.2 ± 2.2	1.3 ± 2.3	0.6 ± 2.1	5.0
Ba-La-140	0.3 ± 1.4	1.0 ± 2.2	-2.0 ± 1.8	5.0
Other Gammas[a]	0.3 ± 2.1	1.8 ± 2.3	-1.4 ± 2.2	15.0

Collection Date	10-08-03	11-05-03	12-04-03	Required LLD
Lab Code	EMI-5837	EMI-6656	EMI-7229	
Sr-89	-0.2 ± 0.7	-0.7 ± 0.9	-0.7 ± 0.8	5.0
Sr-90	1.0 ± 0.3	1.3 ± 0.4	1.5 ± 0.4	1.0
I-131	0.01 ± 0.18	0.09 ± 0.16	-0.01 ± 0.13	0.5
K-40	1464 ± 136	1407 ± 114	1343 ± 118	
Cs-134	0.8 ± 2.3	0.2 ± 2.6	1.1 ± 2.9	5.0
Cs-137	1.1 ± 2.3	-0.6 ± 2.7	2.6 ± 2.3	5.0
Ba-La-140	-1.3 ± 2.7	1.4 ± 1.3	-4.3 ± 2.2	5.0
Other Gammas[a]	1.1 ± 2.5	-0.3 ± 2.7	1.2 ± 2.6	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-21 Strutz Dairy Farm

Collection Date	01-08-03	02-05-03	03-05-03	Required LLD
Lab Code	EMI-122	EMI-486	EMI-928	
Sr-89	-1.6 ± 1.1	0.5 ± 0.8	-0.5 ± 0.7	5.0
Sr-90	2.5 ± 0.4	0.6 ± 0.3	0.9 ± 0.3	1.0
I-131	-0.01 ± 0.17	-0.13 ± 0.13	-0.02 ± 0.15	0.5
K-40	1503 ± 115	1515 ± 118	1449 ± 121	
Cs-134	0.2 ± 2.3	-2.3 ± 2.2	1.0 ± 2.3	5.0
Cs-137	-0.4 ± 2.3	1.9 ± 1.9	1.6 ± 2.1	5.0
Ba-La-140	-3.0 ± 2.3	-1.8 ± 2.5	-1.4 ± 2.3	5.0
Other Gammas[a]	0.1 ± 2.3	0.1 ± 2.1	0.5 ± 2.3	15.0

Collection Date	04-02-03	05-07-03	06-04-03	Required LLD
Lab Code	EMI-1439	EMI-2303	EMI-2944	
Sr-89	0.4 ± 0.7	-1.0 ± 0.7	0.0 ± 0.7	5.0
Sr-90	0.6 ± 0.3	1.5 ± 0.4	0.7 ± 0.3	1.0
I-131	-0.06 ± 0.13	0.02 ± 0.22	0.00 ± 0.15	0.5
K-40	1417 ± 112	1388 ± 110	1261 ± 112	
Cs-134	1.5 ± 1.8	2.2 ± 2.3	2.1 ± 2.4	5.0
Cs-137	-0.3 ± 2.0	0.5 ± 2.4	-2.7 ± 2.3	5.0
Ba-La-140	1.2 ± 1.9	-2.2 ± 2.2	-2.2 ± 2.0	5.0
Other Gammas[a]	-1.9 ± 2.3	0.3 ± 2.0	-1.4 ± 2.5	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN MILK SAMPLES

(Monthly Collections)

Sample Description and Concentration (pCi/L)

E-21 Strutz Dairy Farm

Collection Date	07-02-03	08-06-03	09-03-03	Required LLD
Lab Code	EMI-3609	EMI-4482,3	EMI-4965	
Sr-89	0.0 ± 1.0	-0.7 ± 0.8	0.5 ± 1.0	5.0
Sr-90	1.4 ± 0.4	0.8 ± 0.2	0.5 ± 0.4	1.0
I-131	0.10 ± 0.19	0.11 ± 0.21	-0.01 ± 0.18	0.5
K-40	1491 ± 118	1336 ± 82	1483 ± 119	
Cs-134	0.2 ± 2.0	-1.7 ± 2.3	-0.3 ± 2.0	5.0
Cs-137	0.9 ± 1.9	-1.1 ± 2.2	0.6 ± 2.2	5.0
Ba-La-140	-0.2 ± 1.4	-3.0 ± 2.2	1.5 ± 2.0	5.0
Other Gammas[a]	0.6 ± 2.1	-0.8 ± 2.1	2.6 ± 2.1	15.0

Collection Date	10-08-03	11-05-03	12-03-03	Required LLD
Lab Code	EMI-5838,9	EMI-6657	EMI-7230	
Sr-89	0.1 ± 0.7	-2.1 ± 0.5	-0.6 ± 0.7	5.0
Sr-90	0.9 ± 0.2	1.3 ± 0.1	0.9 ± 0.3	1.0
I-131	-0.10 ± 0.19	0.05 ± 0.18	-0.02 ± 0.19	0.5
K-40	1389 ± 83	1329 ± 119	1281 ± 113	
Cs-134	0.1 ± 2.6	0.8 ± 2.6	1.2 ± 2.5	5.0
Cs-137	1.2 ± 2.2	2.4 ± 2.4	1.1 ± 2.4	5.0
Ba-La-140	0.6 ± 1.8	-0.2 ± 1.7	2.4 ± 2.1	5.0
Other Gammas[a]	-1.6 ± 2.3	-1.2 ± 2.6	-0.4 ± 2.1	15.0

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN WELL WATER SAMPLES, E-10

(Quarterly Collections)

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Req. LLD
Collection Date	01-15-03	04-16-03	07-09-03	10-12-03	
Lab Code	EWW-244	EWW-1928	EWW-3790	EWW-6046	
Gross Beta	0.1 ± 1.9	0.2 ± 0.4	0.9 ± 1.7	0.1 ± 1.5	4.0
H-3	-20.4 ± 65.5	1.8 ± 64.9	54.3 ± 81.0	-51.1 ± 78.5	500
Sr-89	0.4 ± 0.8	0.0 ± 0.6	0.7 ± 0.7	0.8 ± 0.6	5.0
Sr-90	0.5 ± 0.3	0.4 ± 0.3	-0.2 ± 0.3	-0.1 ± 0.3	1.0
I-131	-0.10 ± 0.17	-0.04 ± 0.17	0.02 ± 0.15	-0.09 ± 0.16	0.5
Mn-54	-1.4 ± 1.6	-0.7 ± 1.7	-2.6 ± 3.1	2.8 ± 2.8	10
Fe-59	-2.5 ± 3.0	-2.9 ± 3.7	-1.9 ± 6.7	-3.2 ± 5.7	30
Co-58	0.2 ± 1.6	1.5 ± 1.9	-0.7 ± 3.0	1.9 ± 3.0	10
Co-60	0.9 ± 1.8	-0.4 ± 1.8	0.1 ± 4.3	0.4 ± 4.0	10
Zn-65	-10.4 ± 4.7	-0.4 ± 5.1	-6.7 ± 8.1	-1.2 ± 6.2	30
Zr-Nb-95	-1.2 ± 2.1	-1.9 ± 2.3	1.6 ± 2.8	-3.6 ± 3.2	15
Cs-134	0.5 ± 2.0	-0.1 ± 2.2	0.3 ± 4.0	2.2 ± 3.7	10
Cs-137	-0.4 ± 2.0	0.2 ± 2.1	1.1 ± 3.1	1.6 ± 3.3	10
Ba-La-140	-1.1 ± 1.9	0.6 ± 2.2	2.3 ± 3.2	-5.0 ± 4.7	15
Other Gammas[a]	0.4 ± 1.7	-0.6 ± 2.0	-1.1 ± 2.7	-1.6 ± 2.4	30

[a] Ru-103

POINT BEACH

Lake water, analyses for gross beta, iodine-131 and gamma emitting isotopes.
Location: E-01 (Meteorological Tower)
Collection: Monthly composites Units: pCi/L

Lab Code	ELW-241	ELW-679	ELW-1133	ELW-1921	
Date Collected	01-15-03	02-13-03	03-13-03	04-15-03	Req. LLD
Gross beta	2.3 ± 0.6	2.2 ± 0.5	2.3 ± 0.5	3.3 ± 0.6	4.0
I-131	-0.12 ± 0.17	-0.01 ± 0.16	-0.10 ± 0.16	0.20 ± 0.21	0.5
Be-7	-0.1 ± 25.6	-5.4 ± 29.7	5.7 ± 19.2	1.4 ± 14.2	
Mn-54	1.7 ± 3.1	-4.8 ± 3.9	-0.8 ± 1.9	0.4 ± 1.6	10
Fe-59	0.7 ± 5.5	-4.7 ± 7.0	2.3 ± 3.5	0.1 ± 3.1	30
Co-58	-1.1 ± 3.6	4.3 ± 3.1	-0.4 ± 2.1	0.7 ± 1.5	10
Co-60	-3.4 ± 4.1	3.8 ± 3.3	-0.4 ± 1.8	0.3 ± 1.3	10
Zn-65	0.8 ± 6.2	-12.7 ± 9.5	-0.9 ± 4.1	-1.2 ± 3.3	30
Zr-Nb-95	1.0 ± 2.7	2.0 ± 3.8	1.4 ± 1.9	-1.7 ± 1.6	15
Ru-103	-1.4 ± 3.2	0.1 ± 3.5	-1.7 ± 2.4	0.2 ± 1.6	15
Cs-134	-3.9 ± 4.1	2.0 ± 4.0	-0.7 ± 2.1	-0.8 ± 1.6	10
Cs-137	-0.7 ± 3.4	2.3 ± 3.8	-0.1 ± 2.3	0.4 ± 1.8	10
Ba-La-140	-5.5 ± 3.8	-4.3 ± 3.5	-1.2 ± 2.0	-0.3 ± 1.1	15

Lab Code	ELW-2516	ELW-3174	ELW-3785	ELW-4672	
Date Collected	05-13-03	06-11-03	07-09-03	08-14-03	Req. LLD
Gross beta	4.4 ± 0.7	2.1 ± 0.5	1.9 ± 0.6	2.0 ± 0.6	4.0
I-131	-0.11 ± 0.16	0.11 ± 0.17	-0.01 ± 0.15	-0.02 ± 0.16	0.5
Be-7	-3.5 ± 27.4	8.9 ± 17.7	9.4 ± 13.8	2.3 ± 21.4	
Mn-54	1.0 ± 3.9	0.4 ± 1.9	0.1 ± 1.9	-1.0 ± 2.5	10
Fe-59	-1.5 ± 8.2	-2.0 ± 3.3	3.1 ± 4.4	-3.0 ± 5.0	30
Co-58	0.9 ± 3.2	0.5 ± 1.8	-0.5 ± 2.2	1.1 ± 2.4	10
Co-60	-1.6 ± 4.5	0.8 ± 1.8	0.1 ± 1.9	0.4 ± 2.1	10
Zn-65	1.5 ± 7.5	-3.1 ± 3.5	1.9 ± 4.8	-4.9 ± 6.1	30
Zr-Nb-95	-1.1 ± 3.0	0.7 ± 1.8	0.2 ± 2.0	0.2 ± 2.4	15
Ru-103	-2.9 ± 2.7	-0.8 ± 2.2	0.8 ± 2.0	-0.6 ± 2.6	15
Cs-134	-0.8 ± 3.5	-0.7 ± 2.0	-0.5 ± 2.3	-0.9 ± 2.9	10
Cs-137	1.7 ± 3.6	-0.8 ± 2.1	1.4 ± 2.2	2.3 ± 2.6	10
Ba-La-140	2.4 ± 4.6	-1.5 ± 1.9	-0.7 ± 2.5	2.9 ± 3.1	15

Lab Code	ELW-5295	ELW-6042	ELW-6780	ELW-7512	
Date Collected	09-12-03	10-12-03	11-08-03	12-11-03	Req. LLD
Gross beta	2.8 ± 0.6	2.3 ± 0.5	2.9 ± 0.7	3.1 ± 0.4	4.0
I-131	-0.11 ± 0.16	-0.09 ± 0.17	0.10 ± 0.12	0.12 ± 0.17	0.5
Be-7	2.7 ± 15.1	9.2 ± 15.8	-11.6 ± 18.8	7.6 ± 20.5	
Mn-54	-0.1 ± 1.6	1.7 ± 1.6	-0.1 ± 1.8	-2.0 ± 2.7	10
Fe-59	-1.0 ± 2.9	-0.5 ± 3.1	-0.2 ± 3.5	-1.9 ± 5.3	30
Co-58	-1.2 ± 1.4	0.2 ± 1.7	-1.4 ± 1.7	2.7 ± 2.9	10
Co-60	-0.1 ± 1.4	1.0 ± 2.1	0.2 ± 1.5	-3.6 ± 4.1	10
Zn-65	0.8 ± 3.1	-1.3 ± 3.8	-3.9 ± 4.3	3.6 ± 7.4	30
Zr-Nb-95	0.4 ± 1.6	-1.8 ± 1.8	1.0 ± 1.9	-0.3 ± 3.1	15
Ru-103	-0.7 ± 1.6	0.2 ± 1.7	0.6 ± 1.9	-1.8 ± 2.4	15
Cs-134	1.8 ± 1.7	-1.6 ± 2.0	-0.1 ± 2.0	-1.6 ± 2.7	10
Cs-137	0.2 ± 1.7	0.2 ± 1.8	0.2 ± 2.0	1.4 ± 2.6	10
Ba-La-140	-0.8 ± 1.5	-0.1 ± 1.9	-0.9 ± 2.4	1.8 ± 2.6	15

POINT BEACH

Lake water, analyses for gross beta, iodine-131 and gamma emitting isotopes.
Location: E-05 (Two Creeks Park)
Collection: Monthly composites Units: pCi/L

Lab Code	ELW-242	ELW-680	ELW-1134	ELW-1922	
Date Collected	01-15-03	02-13-03	03-13-03	04-15-03	Req. LLD
Gross beta	2.8 ± 0.7	2.7 ± 0.6	2.9 ± 0.6	2.3 ± 0.5	4.0
I-131	0.04 ± 0.20	-0.14 ± 0.16	0.25 ± 0.25	0.06 ± 0.18	0.5
Be-7	-3.8 ± 22.6	21.5 ± 20.1	-7.1 ± 17.7	2.0 ± 17.3	
Mn-54	0.1 ± 2.1	-1.7 ± 2.9	-0.8 ± 1.8	0.6 ± 1.7	10
Fe-59	0.1 ± 5.2	-3.6 ± 5.2	-1.1 ± 2.9	2.7 ± 3.9	30
Co-58	0.4 ± 2.4	1.0 ± 1.9	-0.2 ± 1.5	2.0 ± 1.6	10
Co-60	-3.0 ± 2.8	1.9 ± 2.8	1.0 ± 1.8	-0.8 ± 2.1	10
Zn-65	-3.5 ± 5.3	2.5 ± 5.0	2.5 ± 3.1	1.7 ± 3.7	30
Zr-Nb-95	-2.3 ± 2.2	0.1 ± 2.3	0.1 ± 3.8	1.4 ± 1.8	15
Ru-103	-1.5 ± 2.2	1.4 ± 2.5	-1.8 ± 1.9	0.8 ± 2.0	15
Cs-134	2.8 ± 2.0	-1.4 ± 3.4	-1.0 ± 1.9	-0.3 ± 2.1	10
Cs-137	3.8 ± 3.2	1.4 ± 2.9	1.0 ± 1.8	-0.5 ± 2.0	10
Ba-La-140	3.0 ± 3.7	-0.9 ± 4.4	-1.3 ± 1.5	-0.7 ± 1.6	15

Lab Code	ELW-2517	ELW-3175	ELW-3786,7	ELW-4673,4	
Date Collected	05-13-03	06-11-03	07-09-03	08-13-03	Req. LLD
Gross beta	5.8 ± 0.8	4.5 ± 0.6	2.5 ± 0.4	3.3 ± 0.5	4.0
I-131	-0.09 ± 0.17	-0.03 ± 0.17	-0.01 ± 0.22	0.03 ± 0.24	0.5
Be-7	8.7 ± 22.7	-7.1 ± 18.6	3.5 ± 17.6	-6.3 ± 14.7	
Mn-54	1.1 ± 2.4	0.7 ± 1.8	-0.6 ± 2.4	-0.4 ± 1.6	10
Fe-59	1.3 ± 4.4	0.5 ± 3.9	-1.1 ± 4.5	0.1 ± 2.5	30
Co-58	-1.8 ± 2.2	0.0 ± 1.7	1.0 ± 2.1	-1.0 ± 1.6	10
Co-60	1.5 ± 1.7	1.2 ± 1.6	-0.4 ± 2.7	1.1 ± 1.5	10
Zn-65	-4.3 ± 5.1	-2.8 ± 3.7	0.7 ± 4.0	-0.8 ± 3.1	30
Zr-Nb-95	1.0 ± 2.7	-0.5 ± 1.8	-1.2 ± 2.2	-0.5 ± 1.6	15
Ru-103	-1.9 ± 2.3	1.4 ± 2.0	2.2 ± 2.0	-0.8 ± 1.8	15
Cs-134	-0.9 ± 3.2	1.1 ± 1.9	0.3 ± 2.5	-0.5 ± 1.6	10
Cs-137	0.5 ± 2.9	-0.3 ± 2.2	-2.0 ± 2.3	0.4 ± 1.5	10
Ba-La-140	-2.5 ± 3.1	-0.7 ± 2.1	-1.7 ± 3.5	-0.1 ± 1.4	15

Lab Code	ELW-5296	ELW-6043	ELW-6781	ELW-7513	
Date Collected	09-12-03	10-12-03	11-08-03	12-10-03	Req. LLD
Gross beta	2.2 ± 0.6	2.0 ± 0.5	3.0 ± 0.7	3.1 ± 0.4	4.0
I-131	-0.06 ± 0.17	0.11 ± 0.17	0.01 ± 0.14	0.15 ± 0.16	0.5
Be-7	0.3 ± 12.6	2.0 ± 16.6	-20.9 ± 25.3	13.0 ± 16.3	
Mn-54	0.4 ± 1.1	1.8 ± 2.7	0.6 ± 3.5	-2.1 ± 2.3	10
Fe-59	0.4 ± 2.4	-1.0 ± 5.6	-1.5 ± 7.6	-3.1 ± 3.4	30
Co-58	-0.1 ± 1.1	1.2 ± 2.8	-0.6 ± 3.3	-0.1 ± 1.5	10
Co-60	-0.5 ± 1.2	1.2 ± 2.4	0.7 ± 3.5	0.4 ± 1.6	10
Zn-65	-2.6 ± 2.9	-0.1 ± 2.2	4.2 ± 7.5	-4.0 ± 4.9	30
Zr-Nb-95	0.7 ± 1.5	0.3 ± 2.1	-4.5 ± 3.6	-1.7 ± 1.9	15
Ru-103	-0.1 ± 1.5	0.1 ± 2.1	-3.1 ± 3.0	-1.1 ± 1.8	15
Cs-134	0.5 ± 1.4	0.3 ± 2.6	2.1 ± 4.0	1.4 ± 1.8	10
Cs-137	-0.7 ± 1.2	0.8 ± 2.5	1.1 ± 3.0	-0.9 ± 2.2	10
Ba-La-140	-1.4 ± 1.7	3.4 ± 3.5	3.9 ± 3.0	-4.6 ± 2.8	15

POINT BEACH

Lake water, analyses for gross beta, iodine-131 and gamma emitting isotopes.
Location: E-06 (Coast Guard Station)
Collection: Monthly composites Units: pCi/L

Lab Code	NS[a]	ELW-681	ELW-1135	ELW-1923	
Date Collected	-	02-13-03	03-13-03	04-15-03	Req. LLD
Gross beta	-	3.8 ± 0.6	2.0 ± 0.5	3.4 ± 0.6	4.0
I-131	-	0.04 ± 0.15	0.16 ± 0.21	0.02 ± 0.15	0.5
Be-7	-	-20.7 ± 29.2	6.7 ± 25.1	-23.7 ± 27.4	
Mn-54	-	-1.2 ± 4.0	1.9 ± 3.1	-1.3 ± 3.4	10
Fe-59	-	6.5 ± 5.0	3.2 ± 6.1	-1.2 ± 5.5	30
Co-58	-	-0.7 ± 3.1	-3.4 ± 3.1	-0.8 ± 3.4	10
Co-60	-	1.1 ± 3.1	1.5 ± 3.9	0.3 ± 3.5	10
Zn-65	-	-4.1 ± 7.6	4.6 ± 5.7	-2.7 ± 6.7	30
Zr-Nb-95	-	-2.4 ± 4.0	2.8 ± 3.4	-0.4 ± 2.8	15
Ru-103	-	0.5 ± 3.4	-0.3 ± 2.8	2.5 ± 2.9	15
Cs-134	-	-0.6 ± 4.1	-2.9 ± 3.8	1.0 ± 3.7	10
Cs-137	-	1.2 ± 3.5	2.6 ± 3.8	0.1 ± 3.6	10
Ba-La-140	-	2.2 ± 4.8	2.1 ± 4.2	-4.6 ± 3.7	15

Lab Code	ELW-2518	ELW-3176	ELW-3788	ELW-4675	
Date Collected	05-13-03	06-11-03	07-09-03	08-13-03	Req. LLD
Gross beta	3.1 ± 0.6	2.3 ± 0.4	3.5 ± 0.7	2.1 ± 0.6	4.0
I-131	-0.06 ± 0.19	-0.09 ± 0.18	0.14 ± 0.23	0.13 ± 0.21	0.5
Be-7	-4.1 ± 21.0	2.4 ± 12.8	1.7 ± 15.1	0.3 ± 25.1	
Mn-54	9.5 ± 2.2	0.8 ± 1.4	1.3 ± 1.4	-0.6 ± 3.0	10
Fe-59	-4.2 ± 4.4	1.3 ± 2.6	1.2 ± 2.6	0.4 ± 5.9	30
Co-58	0.1 ± 2.5	-0.6 ± 1.7	0.2 ± 1.8	0.1 ± 2.6	10
Co-60	2.5 ± 2.5	-0.1 ± 2.1	0.2 ± 1.8	-0.6 ± 2.3	10
Zn-65	-3.4 ± 5.5	1.2 ± 4.1	-1.5 ± 3.7	-2.9 ± 7.0	30
Zr-Nb-95	-0.3 ± 2.4	-0.8 ± 1.4	-0.7 ± 1.7	1.1 ± 3.2	15
Ru-103	-2.1 ± 2.3	-0.8 ± 1.6	-1.5 ± 1.8	0.1 ± 2.4	15
Cs-134	-1.5 ± 3.0	-0.4 ± 1.5	0.9 ± 1.7	-1.9 ± 3.0	10
Cs-137	0.4 ± 2.6	1.3 ± 1.8	0.8 ± 1.9	-0.6 ± 3.0	10
Ba-La-140	-2.0 ± 3.4	1.7 ± 1.6	-3.1 ± 2.5	-4.3 ± 3.6	15

Lab Code	ELW-5297	ELW-6044	ELW-6782	ELW-7514	
Date Collected	09-12-03	10-12-03	11-08-03	12-10-03	Req. LLD
Gross beta	2.9 ± 0.7	3.1 ± 0.6	2.9 ± 0.6	2.7 ± 0.4	4.0
I-131	0.11 ± 0.19	-0.10 ± 0.18	0.01 ± 0.15	0.14 ± 0.17	0.5
Be-7	5.8 ± 18.4	12.8 ± 17.6	-0.4 ± 13.9	6.3 ± 16.7	
Mn-54	0.1 ± 2.3	-0.3 ± 2.0	1.3 ± 1.4	0.9 ± 1.9	10
Fe-59	-4.0 ± 4.4	-3.0 ± 3.1	1.4 ± 2.6	-0.4 ± 3.2	30
Co-58	2.0 ± 2.3	-0.8 ± 1.8	1.7 ± 1.7	-0.2 ± 1.8	10
Co-60	-0.3 ± 2.4	-1.5 ± 2.0	-0.2 ± 1.5	-1.0 ± 1.8	10
Zn-65	1.3 ± 4.5	3.2 ± 3.6	0.3 ± 2.3	-3.6 ± 3.9	30
Zr-Nb-95	-1.8 ± 2.1	-0.3 ± 2.0	-1.3 ± 1.7	-2.4 ± 2.0	15
Ru-103	-1.3 ± 2.0	-0.6 ± 2.2	-3.0 ± 1.8	-4.2 ± 1.9	15
Cs-134	0.5 ± 2.4	-0.2 ± 1.8	0.1 ± 1.9	-0.4 ± 1.8	10
Cs-137	-0.7 ± 2.9	1.1 ± 2.0	1.1 ± 1.9	-0.9 ± 2.1	10
Ba-La-140	0.9 ± 1.9	0.9 ± 1.9	-1.8 ± 1.8	2.4 ± 2.1	15

[a] "NS" = No sample; see Table 2.0, "Listing of Missed Sample."

POINT BEACH

Lake water, analyses for gross beta, iodine-131 and gamma emitting isotopes.
Location: E-33 (Nature Conservancy)
Collection: Monthly composites Units: pCi/L

Lab Code	ELW-243	ELW-682	ELW-1136	ELW-1924	
Date Collected	01-15-03	02-13-03	03-13-03	04-15-03	Req. LLD
Gross beta	2.9 ± 0.6	2.5 ± 0.5	2.7 ± 0.6	2.0 ± 0.5	4.0
I-131	-0.16 ± 0.18	0.07 ± 0.18	0.12 ± 0.21	0.12 ± 0.15	0.5
Be-7	-1.2 ± 18.0	-14.8 ± 19.2	33.1 ± 27.0	-1.4 ± 16.8	
Mn-54	0.9 ± 1.5	1.4 ± 2.0	-1.5 ± 3.4	-0.1 ± 1.5	10
Fe-59	0.8 ± 3.5	0.7 ± 3.8	7.7 ± 6.3	3.1 ± 2.8	30
Co-58	0.3 ± 1.5	0.3 ± 1.8	-1.3 ± 3.0	0.7 ± 1.6	10
Co-60	-0.5 ± 1.9	-0.1 ± 1.6	0.8 ± 3.8	-0.1 ± 1.3	10
Zn-65	3.7 ± 3.9	0.5 ± 3.3	-5.3 ± 5.9	-1.5 ± 3.8	30
Zr-Nb-95	1.2 ± 1.9	1.8 ± 2.0	0.7 ± 3.1	0.4 ± 1.8	15
Ru-103	-0.2 ± 1.7	-2.2 ± 2.0	3.0 ± 3.0	-1.6 ± 1.9	15
Cs-134	-1.4 ± 1.9	-1.9 ± 2.4	-1.2 ± 3.5	-0.7 ± 2.1	10
Cs-137	0.4 ± 1.9	-0.6 ± 2.4	1.1 ± 3.1	-0.8 ± 1.9	10
Ba-La-140	1.7 ± 1.5	-0.1 ± 2.7	-2.4 ± 4.1	-0.6 ± 2.0	15

Lab Code	ELW-2519	ELW-3177	ELW-3789	ELW-4676	
Date Collected	05-13-03	06-11-03	07-09-03	08-13-03	Req. LLD
Gross beta	3.4 ± 0.7	5.0 ± 0.6	3.8 ± 0.7	1.9 ± 0.6	4.0
I-131	0.12 ± 0.18	-0.04 ± 0.17	-0.07 ± 0.15	0.05 ± 0.17	0.5
Be-7	5.9 ± 10.8	3.6 ± 25.5	16.0 ± 14.5	6.5 ± 13.0	
Mn-54	-0.3 ± 1.0	4.7 ± 4.6	-0.2 ± 1.3	0.8 ± 1.3	10
Fe-59	-1.8 ± 2.1	3.6 ± 8.0	-0.3 ± 3.4	-0.5 ± 2.4	30
Co-58	0.6 ± 1.0	4.3 ± 4.0	0.1 ± 1.5	-0.5 ± 1.3	10
Co-60	0.7 ± 1.3	-0.7 ± 5.8	-1.2 ± 1.7	0.7 ± 1.4	10
Zn-65	-3.1 ± 2.8	2.4 ± 9.8	1.8 ± 3.5	1.8 ± 2.8	30
Zr-Nb-95	0.7 ± 1.1	0.2 ± 4.5	-0.2 ± 1.5	0.3 ± 1.4	15
Ru-103	-0.2 ± 1.3	2.5 ± 4.1	-0.1 ± 1.6	-1.0 ± 1.5	15
Cs-134	-0.3 ± 1.3	1.0 ± 5.2	1.1 ± 1.6	0.9 ± 1.5	10
Cs-137	-0.2 ± 1.3	2.2 ± 5.2	-0.1 ± 1.5	1.2 ± 1.5	10
Ba-La-140	0.8 ± 1.2	4.9 ± 4.8	-5.3 ± 2.1	-2.0 ± 1.9	15

Lab Code	ELW-5298	ELW-6045	ELW-6783	ELW-7515	
Date Collected	09-12-03	10-12-03	11-08-03	12-10-03	Req. LLD
Gross beta	5.6 ± 0.8	3.0 ± 0.6	2.9 ± 0.7	3.1 ± 0.4	4.0
I-131	0.16 ± 0.17	-0.07 ± 0.16	0.08 ± 0.13	-0.02 ± 0.18	0.5
Be-7	2.4 ± 15.0	-5.3 ± 17.4	-11.8 ± 21.9	-15.1 ± 19.7	
Mn-54	1.3 ± 1.5	2.5 ± 1.8	-0.3 ± 1.9	-1.0 ± 2.1	10
Fe-59	-1.8 ± 3.0	-3.1 ± 3.7	-1.6 ± 3.9	5.1 ± 3.6	30
Co-58	1.1 ± 1.3	-2.0 ± 2.0	-0.9 ± 1.7	1.3 ± 2.1	10
Co-60	0.4 ± 1.6	0.7 ± 2.1	-0.4 ± 2.2	-2.9 ± 2.5	10
Zn-65	-1.3 ± 3.5	-5.7 ± 4.3	-10.6 ± 5.3	-3.6 ± 4.9	30
Zr-Nb-95	-2.3 ± 1.6	-1.4 ± 2.1	-0.5 ± 2.0	0.2 ± 2.0	15
Ru-103	-1.2 ± 1.6	-1.4 ± 2.1	1.4 ± 2.2	-3.4 ± 2.3	15
Cs-134	2.3 ± 1.8	-0.7 ± 2.3	-2.1 ± 2.5	-2.8 ± 2.6	10
Cs-137	0.0 ± 1.6	0.9 ± 1.9	-0.5 ± 2.5	1.3 ± 2.5	10
Ba-La-140	-0.4 ± 1.8	-1.1 ± 2.8	-0.1 ± 2.2	0.4 ± 2.0	15

POINT BEACH

Lake water, analyses for tritium, strontium-89 and strontium-90.
Collection: Quarterly composites of weekly grab samples
Units: pCi/L

Location	E-01 (Meteorological Tower)			
Period	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Lab Code	ELW-1152,3[a]	ELW-3299	ELW-5370	ELW-7672
H-3	1121 ± 86	162 ± 88	68 ± 90	236 ± 92
Sr-89	-0.06 ± 0.65	-1.97 ± 1.03	0.17 ± 0.57	0.84 ± 0.88
Sr-90	0.30 ± 0.33	1.04 ± 0.48	0.47 ± 0.31	0.38 ± 0.29

Location	E-05 (Two Creeks Park)			
Period	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Lab Code	ELW-1154[a]	ELW-3300	ELW-5371	ELW-7673
H-3	4868 ± 208	1219 ± 126	139 ± 93	135 ± 88
Sr-89	0.11 ± 0.58	-1.79 ± 1.01	0.89 ± 0.69	1.13 ± 1.02
Sr-90	0.32 ± 0.27	1.2 ± 0.46	0.18 ± 0.28	0.32 ± 0.33

Location	E-06 (Coast Guard Station)			
Period	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Lab Code	ELW-1155[a]	ELW-3301	ELW-5372	ELW-7674
H-3	668 ± 107	176 ± 89	131 ± 92	240 ± 93
Sr-89	0.20 ± 0.58	-0.60 ± 1.27	-0.30 ± 0.53	0.42 ± 0.69
Sr-90	0.43 ± 0.28	1.25 ± 0.47	0.53 ± 0.30	0.41 ± 0.27

Location	E-33 (Nature Conservancy)			
Period	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.
Lab Code	ELW-1156[a]	ELW-3302	ELW-5373	ELW-7675
H-3	5712 ± 222	43 ± 83	66 ± 90	228 ± 92
Sr-89	0.11 ± 0.62	-1.29 ± 0.97	-0.62 ± 0.56	0.12 ± 0.73
Sr-90	0.43 ± 0.29	0.96 ± 0.43	0.75 ± 0.31	0.36 ± 0.29

[a] All tritiums repeated with similar results.

Note: pages 23 and 24 are intentionally left out.

POINT BEACH NUCLEAR PLANT

Fish, analyses for gross beta and gamma emitting isotopes.
Location: E-13
Collection: 3x / year Units: pCi/g wet

	Sample Description and Concentration				Required LLD
Collection Date	03-14-03	03-14-03	03-14-03	08-13-03	
Lab Code	EF-1120,1	EF-1122	EF-1123	EF-4622	
Type	Lake Trout	Lake Trout	Chinook Salmon	Lake Trout	
Ratio (wet/dry wt.)	3.12	2.68	3.18	4.30	
Gross Beta	2.08 ± 0.04	3.89 ± 0.08	4.17 ± 0.01	3.90 ± 0.13	0.5
K-40	1.91 ± 0.23	3.24 ± 0.29	3.52 ± 0.28	2.66 ± 0.41	
Mn-54	-0.005 ± 0.005	0.004 ± 0.005	-0.002 ± 0.005	-0.004 ± 0.009	0.13
Fe-59	-0.004 ± 0.010	-0.009 ± 0.013	0.001 ± 0.011	0.025 ± 0.017	0.26
Co-58	0.005 ± 0.005	0.000 ± 0.004	0.001 ± 0.005	0.005 ± 0.007	0.13
Co-60	-0.001 ± 0.006	0.005 ± 0.006	-0.002 ± 0.006	0.001 ± 0.010	0.13
Zn-65	-0.001 ± 0.012	0.005 ± 0.013	-0.004 ± 0.012	-0.002 ± 0.019	0.26
Ru-103	-0.007 ± 0.007	0.002 ± 0.006	-0.001 ± 0.005	0.006 ± 0.007	0.5
Cs-134	-0.009 ± 0.007	-0.002 ± 0.007	-0.002 ± 0.006	-0.003 ± 0.008	0.13
Cs-137	0.047 ± 0.013	0.064 ± 0.012	0.039 ± 0.015	0.060 ± 0.022	0.15
Collection Date	08-13-03	08-13-03	08-13-03	12-10-03	
Lab Code	EF-4623	EF-4624	EF-4625	EF-7407	
Type	Salmon	Yellow Perch	Sucker	Lake Trout	
Ratio (wet/dry wt.)	6.66	6.33	4.33	5.10	
Gross Beta	2.10 ± 0.06	3.63 ± 0.10	3.92 ± 0.11	3.09 ± 0.16	0.5
K-40	2.17 ± 0.76	2.22 ± 0.82	2.57 ± 0.42	2.47 ± 0.44	
Mn-54	-0.005 ± 0.023	-0.001 ± 0.020	0.004 ± 0.008	-0.001 ± 0.007	0.13
Fe-59	-0.014 ± 0.053	-0.038 ± 0.046	0.026 ± 0.021	0.003 ± 0.019	0.26
Co-58	0.009 ± 0.018	-0.011 ± 0.019	0.008 ± 0.009	-0.008 ± 0.008	0.13
Co-60	0.013 ± 0.027	0.008 ± 0.024	-0.003 ± 0.010	-0.008 ± 0.012	0.13
Zn-65	0.010 ± 0.048	0.048 ± 0.040	0.005 ± 0.021	-0.020 ± 0.021	0.26
Ru-103	-0.010 ± 0.020	-0.015 ± 0.022	-0.018 ± 0.009	-0.013 ± 0.008	0.5
Cs-134	-0.011 ± 0.026	0.018 ± 0.025	-0.001 ± 0.009	-0.009 ± 0.010	0.13
Cs-137	0.009 ± 0.032	-0.009 ± 0.021	0.029 ± 0.016	0.066 ± 0.020	0.15

POINT BEACH NUCLEAR PLANT

Fish, analyses for gross beta and gamma emitting isotopes.
Location: E-13
Collection: 3x / year Units: pCi/L

	Sample Description and Concentration (pCi/g wet)	Required LLD
Collection Date	12-10-03	
Lab Code	EF-7408	
Type	Sucker	
Ratio (wet/dry wt.)	3.73	
Gross Beta	2.99 ± 0.14	0.5
K-40	2.72 ± 0.39	
Mn-54	-0.004 ± 0.009	0.13
Fe-59	0.015 ± 0.017	0.26
Co-58	-0.004 ± 0.007	0.13
Co-60	0.004 ± 0.010	0.13
Zn-65	-0.012 ± 0.027	0.26
Ru-103	0.001 ± 0.007	0.5
Cs-134	-0.002 ± 0.008	0.13
Cs-137	0.056 ± 0.023	0.15

Note: Page 27 is intentionally left out.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN SHORELINE SEDIMENT SAMPLES

(Semiannual Collections)

Sample Description and Concentration (pCi/g dry)

Collection Date	04-15-03	04-15-03	04-15-03	Required
Lab Code	ESS-1929	ESS-1930	ESS-1931	LLD
Location	E-01	E-05	E-06	
Gross Beta	9.60 ± 2.05	7.39 ± 1.97	7.63 ± 2.07	2.0
Be-7	0.013 ± 0.068	0.010 ± 0.074	0.057 ± 0.051	
K-40	5.39 ± 0.54	6.57 ± 0.53	7.14 ± 0.44	-
Cs-137	0.009 ± 0.012	0.008 ± 0.012	0.042 ± 0.018	0.15
Tl-208	0.033 ± 0.016	0.054 ± 0.022	0.044 ± 0.016	-
Pb-212	0.13 ± 0.023	0.11 ± 0.021	0.08 ± 0.021	-
Bi-214	0.11 ± 0.046	0.18 ± 0.058	0.12 ± 0.030	-
Ra-226	0.16 ± 0.147	0.27 ± 0.144	0.30 ± 0.136	-
Ac-228	0.13 ± 0.056	0.16 ± 0.077	0.20 ± 0.058	-
Collection Date	04-15-03	04-15-03		
Lab Code	ESS-1932	ESS-1933		
Location	E-12	E-33		
Gross Beta	7.47 ± 1.87	9.32 ± 2.17		2.0
Be-7	-0.038 ± 0.078	0.008 ± 0.075		
K-40	6.27 ± 0.55	8.72 ± 0.65		-
Cs-137	0.011 ± 0.011	0.039 ± 0.015		0.15
Tl-208	0.037 ± 0.017	0.040 ± 0.021		-
Pb-212	0.10 ± 0.021	0.15 ± 0.022		-
Bi-214	0.08 ± 0.028	0.13 ± 0.042		-
Ra-226	0.33 ± 0.164	0.34 ± 0.160		-
Ac-228	0.20 ± 0.072	0.18 ± 0.059		-

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN SHORELINE SEDIMENT SAMPLES

(Semiannual Collections)

Sample Description and Concentration (pCi/g dry)

Collection Date	10-13-03	10-12-03	10-12-03	Required
Lab Code	ESS-6047	ESS-6048	ESS-6049	LLD
Location	E-01	E-05	E-06	
Gross Beta	9.37 ± 1.24	10.09 ± 1.31	10.52 ± 1.34	2.0
Be-7	0.063 ± 0.033	0.061 ± 0.055	-0.001 ± 0.040	
K-40	6.72 ± 0.31	8.94 ± 0.52	8.65 ± 0.33	-
Cs-137	0.032 ± 0.012	0.017 ± 0.009	0.032 ± 0.010	0.15
Tl-208	0.046 ± 0.012	0.042 ± 0.021	0.045 ± 0.010	-
Pb-212	0.13 ± 0.013	0.13 ± 0.018	0.13 ± 0.015	-
Bi-214	0.10 ± 0.020	0.15 ± 0.028	0.12 ± 0.018	-
Ra-226	0.35 ± 0.11	0.34 ± 0.14	0.29 ± 0.14	-
Ac-228	0.15 ± 0.039	0.10 ± 0.046	0.14 ± 0.044	-

Collection Date	10-12-03	10-12-03	
Lab Code	ESS-6050	ESS-6051	
Location	E-12	E-33	
Gross Beta	7.59 ± 1.23	10.05 ± 1.58	2.0
Be-7	0.036 ± 0.047	0.041 ± 0.044	
K-40	6.54 ± 0.45	7.91 ± 0.45	-
Cs-137	0.030 ± 0.017	0.016 ± 0.008	0.15
Tl-208	0.048 ± 0.013	0.044 ± 0.016	-
Pb-212	0.13 ± 0.016	0.13 ± 0.017	-
Bi-214	0.08 ± 0.022	0.14 ± 0.033	-
Ra-226	0.27 ± 0.11	0.22 ± 0.11	-
Ac-228	0.12 ± 0.047	0.13 ± 0.052	-

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN SOIL SAMPLES

(Semiannual Collections)

Sample Description and Concentration (pCi/g dry)

Collection Date	05-28-03	05-28-03	05-28-03	Required
Lab Code	ESO-2784	ESO-2785	ESO-2786	LLD
Location	E-01	E-02	E-03	
Gross Beta	15.26 ± 1.58	26.41 ± 1.90	28.72 ± 1.99	2.0
Be-7	0.05 ± 0.06	0.06 ± 0.13	0.05 ± 0.10	
K-40	10.49 ± 0.46	17.43 ± 1.01	19.47 ± 0.84	-
Cs-137	0.12 ± 0.02	0.12 ± 0.03	0.20 ± 0.04	0.15
Tl-208	0.11 ± 0.02	0.20 ± 0.04	0.19 ± 0.03	-
Pb-212	0.29 ± 0.03	0.49 ± 0.04	0.46 ± 0.04	-
Bi-214	0.22 ± 0.04	0.25 ± 0.05	0.37 ± 0.05	-
Ra-226	0.72 ± 0.21	1.08 ± 0.34	0.91 ± 0.28	-
Ac-228	0.36 ± 0.07	0.70 ± 0.13	0.54 ± 0.09	-
Collection Date	05-28-03	05-28-03	05-28-03	
Lab Code	ESO-2787,8	ESO-2789	ESO-2790	
Location	E-04	E-06	E-08	
Gross Beta	20.21 ± 1.22	14.64 ± 1.57	22.25 ± 2.13	2.0
Be-7	-0.02 ± 0.12	0.15 ± 0.09	0.02 ± 0.09	
K-40	14.59 ± 0.72	10.78 ± 0.78	13.33 ± 0.88	-
Cs-137	0.25 ± 0.03	0.45 ± 0.04	0.31 ± 0.04	0.15
Tl-208	0.15 ± 0.03	0.05 ± 0.02	0.10 ± 0.03	-
Pb-212	0.40 ± 0.03	0.17 ± 0.03	0.27 ± 0.03	-
Bi-214	0.26 ± 0.05	0.14 ± 0.04	0.20 ± 0.05	-
Ra-226	0.80 ± 0.24	0.27 ± 0.24	0.51 ± 0.26	-
Ac-228	0.42 ± 0.08	0.17 ± 0.08	0.33 ± 0.11	-
Collection Date	05-28-03	05-28-03		
Lab Code	ESO-2791	ESO-2792		
Location	E-09	E-20		
Gross Beta	22.33 ± 1.95	21.57 ± 2.06		2.0
Be-7	0.05 ± 0.10	0.00 ± 0.13		
K-40	14.59 ± 0.99	13.14 ± 1.02		-
Cs-137	0.03 ± 0.02	0.29 ± 0.05		0.15
Tl-208	0.14 ± 0.04	0.10 ± 0.04		-
Pb-212	0.42 ± 0.04	0.31 ± 0.04		-
Bi-214	0.25 ± 0.05	0.23 ± 0.05		-
Ra-226	0.78 ± 0.30	0.49 ± 0.28		-
Ac-228	0.41 ± 0.14	0.35 ± 0.12		-

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN SOIL SAMPLES

(Semiannual Collections)

Sample Description and Concentration (pCi/g dry)

Collection Date	10-25-03	10-25-03	10-25-03	Required
Lab Code	ESO-6392	ESO-6393,4	ESO-6395	LLD
Location	E-01	E-02	E-03	
Gross Beta	25.18 ± 2.16	22.48 ± 1.38	31.99 ± 2.26	2.0
Be-7	-0.022 ± 0.13	0.17 ± 0.10	0.027 ± 0.12	
K-40	16.88 ± 1.08	14.27 ± 0.59	19.49 ± 1.13	-
Cs-137	0.21 ± 0.05	0.10 ± 0.03	0.31 ± 0.05	0.15
Tl-208	0.18 ± 0.04	0.16 ± 0.03	0.25 ± 0.05	-
Pb-212	0.50 ± 0.04	0.41 ± 0.03	0.62 ± 0.05	-
Bi-214	0.45 ± 0.08	0.36 ± 0.04	0.46 ± 0.09	-
Ra-226	1.07 ± 0.41	0.87 ± 0.20	1.34 ± 0.60	-
Ac-228	0.69 ± 0.14	0.60 ± 0.10	0.92 ± 0.16	-
Collection Date	10-25-03	10-25-03	10-25-03	
Lab Code	ESO-6396	ESO-6397	ESO-6398	
Location	E-04	E-06	E-08	
Gross Beta	25.71 ± 2.24	19.30 ± 1.85	19.57 ± 1.99	2.0
Be-7	0.067 ± 0.10	-0.065 ± 0.09	0.028 ± 0.06	
K-40	18.42 ± 1.04	12.30 ± 0.81	11.27 ± 0.49	-
Cs-137	0.19 ± 0.05	0.61 ± 0.05	0.19 ± 0.02	0.15
Tl-208	0.17 ± 0.04	0.09 ± 0.03	0.08 ± 0.02	-
Pb-212	0.45 ± 0.04	0.23 ± 0.03	0.24 ± 0.02	-
Bi-214	0.37 ± 0.07	0.18 ± 0.05	0.21 ± 0.05	-
Ra-226	0.89 ± 0.34	0.64 ± 0.26	0.49 ± 0.18	-
Ac-228	0.56 ± 0.12	0.29 ± 0.08	0.28 ± 0.07	-
Collection Date	10-25-03	10-25-03		
Lab Code	ESO-6399	ESO-6400		
Location	E-09	E-20		
Gross Beta	28.69 ± 2.22	15.78 ± 1.69		2.0
Be-7	0.14 ± 0.12	0.046 ± 0.07		
K-40	17.38 ± 0.95	10.51 ± 0.48		-
Cs-137	0.14 ± 0.04	0.10 ± 0.04		0.15
Tl-208	0.11 ± 0.03	0.11 ± 0.02		-
Pb-212	0.42 ± 0.04	0.26 ± 0.03		-
Bi-214	0.30 ± 0.05	0.17 ± 0.03		-
Ra-226	0.98 ± 0.33	0.61 ± 0.22		-
Ac-228	0.56 ± 0.14	0.35 ± 0.08		-

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN VEGETATION SAMPLES

(Tri-Annual Collections)

Sample Description and Concentration (pCi/g wet)

Location	E-01	E-02	E-03	
Collection Date	05-28-03	05-28-03	05-28-03	
Lab Code	EG-2776	EG-2777	EG-2778	Req. LLD
Ratio (wet/dry)	4.23	5.3	4.51	-
Gross Beta	3.23 ± 0.08	5.04 ± 0.12	6.66 ± 0.14	0.25
Be-7	0.79 ± 0.20	0.30 ± 0.16	0.22 ± 0.10	0.25
K-40	4.62 ± 0.40	5.23 ± 0.41	5.71 ± 0.62	0.25
I-131	-0.009 ± 0.008	-0.001 ± 0.006	-0.007 ± 0.010	0.060
Cs-134	0.003 ± 0.009	-0.002 ± 0.007	0.005 ± 0.012	0.060
Cs-137	0.000 ± 0.008	-0.001 ± 0.008	0.012 ± 0.013	0.080
Other Gammas[a]	0.004 ± 0.010	0.003 ± 0.008	-0.015 ± 0.015	0.060

Location	E-04	E-06	E-08	
Collection Date	05-28-03	05-28-03	05-28-03	
Lab Code	EG-2779	EG-2780	EG-2781	Req. LLD
Ratio (wet/dry)	5.23	5.62	3.56	-
Gross Beta	5.38 ± 0.12	4.86 ± 0.11	6.66 ± 0.14	0.25
Be-7	0.17 ± 0.13	0.17 ± 0.11	0.63 ± 0.22	0.25
K-40	4.42 ± 0.69	4.02 ± 0.51	4.91 ± 0.60	0.25
I-131	-0.009 ± 0.013	-0.006 ± 0.011	-0.005 ± 0.010	0.060
Cs-134	0.017 ± 0.016	-0.007 ± 0.012	0.003 ± 0.012	0.060
Cs-137	-0.003 ± 0.017	0.022 ± 0.014	0.006 ± 0.013	0.080
Other Gammas[a]	0.022 ± 0.019	0.006 ± 0.016	-0.012 ± 0.010	0.060

Location	E-09	E-20		
Collection Date	05-28-03	05-28-03		
Lab Code	EG-2782	EG-2783		Req. LLD
Ratio (wet/dry)	4.36	3.56		-
Gross Beta	7.00 ± 0.16	6.71 ± 0.15		0.25
Be-7	0.17 ± 0.09	0.22 ± 0.13		0.25
K-40	6.52 ± 0.68	5.76 ± 0.47		0.25
I-131	0.000 ± 0.010	-0.001 ± 0.007		0.060
Cs-134	-0.008 ± 0.014	-0.002 ± 0.009		0.060
Cs-137	-0.006 ± 0.012	-0.009 ± 0.008		0.080
Other Gammas[a]	0.006 ± 0.013	0.002 ± 0.008		0.060

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN VEGETATION SAMPLES
(Tri-Annual Collections)

Sample Description and Concentration (pCi/g wet)

Location	E-01	E-02	E-03	
Collection Date	07-24-03	07-24-03	07-24-03	
Lab Code	EG-4189	EG-4190	EG-4191	Req. LLD
Ratio (wet/dry)	2.62	3.00	2.46	-
Gross Beta	6.44 ± 0.17	5.83 ± 0.21	8.52 ± 0.30	0.25
Be-7	1.36 ± 0.39	1.56 ± 0.28	1.39 ± 0.31	0.25
K-40	5.02 ± 0.80	4.85 ± 0.61	7.63 ± 0.94	0.25
I-131	0.002 ± 0.014	0.004 ± 0.010	0.005 ± 0.015	0.060
Cs-134	0.002 ± 0.019	0.011 ± 0.012	0.008 ± 0.016	0.060
Cs-137	-0.016 ± 0.018	-0.002 ± 0.013	0.011 ± 0.021	0.080
Other Gammas[a]	0.030 ± 0.019	-0.008 ± 0.011	0.003 ± 0.017	0.060

Location	E-04	E-06	E-08	
Collection Date	07-24-03	07-24-03	07-24-03	
Lab Code	EG-4192	EG-4193	EG-4194	Req. LLD
Ratio (wet/dry)	2.90	2.54	2.17	-
Gross Beta	4.76 ± 0.17	4.50 ± 0.16	6.19 ± 0.23	0.25
Be-7	0.97 ± 0.22	1.30 ± 0.32	2.00 ± 0.31	0.25
K-40	5.19 ± 0.57	4.26 ± 0.77	5.25 ± 0.57	0.25
I-131	0.004 ± 0.011	-0.013 ± 0.014	0.009 ± 0.013	0.060
Cs-134	-0.004 ± 0.012	0.001 ± 0.019	-0.012 ± 0.012	0.060
Cs-137	0.014 ± 0.013	0.017 ± 0.023	0.002 ± 0.012	0.080
Other Gammas[a]	-0.005 ± 0.013	-0.002 ± 0.016	-0.006 ± 0.012	0.060

Location	E-09	E-20	
Collection Date	07-24-03	07-24-03	
Lab Code	EG-4195	EG-4196	Req. LLD
Ratio (wet/dry)	2.51	2.28	-
Gross Beta	5.80 ± 0.15	5.04 ± 0.13	0.25
Be-7	1.96 ± 0.30	1.13 ± 0.35	0.25
K-40	5.44 ± 0.62	4.44 ± 0.70	0.25
I-131	0.000 ± 0.010	0.004 ± 0.017	0.060
Cs-134	0.001 ± 0.013	-0.007 ± 0.020	0.060
Cs-137	-0.001 ± 0.012	-0.005 ± 0.015	0.080
Other Gammas[a]	-0.003 ± 0.012	0.005 ± 0.017	0.060

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

RADIOACTIVITY IN VEGETATION SAMPLES
(Tri-Annual Collections)

Sample Description and Concentration (pCi/g wet)

Location	E-01	E-02	E-03	
Collection Date	10-25-03	10-25-03	10-25-03	
Lab Code	EG-6405	EG-6406	EG-6407	Req. LLD
Ratio (wet/dry)	3.97	5.07	6.77	-
Gross Beta	4.98 ± 0.14	7.02 ± 0.17	3.21 ± 0.10	0.25
Be-7	2.78 ± 0.51	1.23 ± 0.31	2.66 ± 0.30	0.25
K-40	2.85 ± 0.83	6.64 ± 0.85	4.14 ± 0.51	0.25
I-131	0.005 ± 0.015	-0.008 ± 0.015	-0.009 ± 0.011	0.060
Cs-134	-0.001 ± 0.021	0.007 ± 0.016	0.004 ± 0.010	0.060
Cs-137	-0.007 ± 0.018	-0.011 ± 0.016	0.002 ± 0.011	0.080
Other Gammas[a]	-0.008 ± 0.020	0.016 ± 0.020	0.014 ± 0.012	0.060

Location	E-04	E-06	E-08	
Collection Date	10-25-03	10-25-03	10-25-03	
Lab Code	EG-6408	EG-6409	EG-6410	Req. LLD
Ratio (wet/dry)	3.31	2.56	1.54	-
Gross Beta	5.93 ± 0.20	5.97 ± 0.16	6.56 ± 0.21	0.25
Be-7	3.02 ± 0.33	3.10 ± 0.53	9.87 ± 0.58	0.25
K-40	5.13 ± 0.51	2.95 ± 0.60	2.81 ± 0.46	0.25
I-131	-0.002 ± 0.011	-0.012 ± 0.017	-0.011 ± 0.016	0.060
Cs-134	0.006 ± 0.016	0.004 ± 0.022	0.005 ± 0.012	0.060
Cs-137	0.005 ± 0.012	0.133 ± 0.046	0.001 ± 0.015	0.080
Other Gammas[a]	0.007 ± 0.009	-0.016 ± 0.024	-0.001 ± 0.011	0.060

Location	E-09	E-20		
Collection Date	10-25-03	10-25-03		
Lab Code	EG-6411	EG-6412		Req. LLD
Ratio (wet/dry)	2.38	4.18		-
Gross Beta	5.47 ± 0.19	5.71 ± 0.16		0.25
Be-7	5.69 ± 0.45	3.65 ± 0.44		0.25
K-40	3.25 ± 0.46	4.92 ± 0.67		0.25
I-131	-0.001 ± 0.013	-0.041 ± 0.020		0.060
Cs-134	-0.005 ± 0.011	0.003 ± 0.017		0.060
Cs-137	0.002 ± 0.013	-0.014 ± 0.018		0.080
Other Gammas[a]	-0.014 ± 0.012	-0.013 ± 0.017		0.060

[a] See Introduction.

POINT BEACH NUCLEAR PLANT

Aquatic Vegetation, analyses for gross beta and gamma emitting isotopes.

Collection: Semiannual Units: pCi/g wet

Sample Description and Concentration				
Collection Date	06-06-03	06-06-03	08-07-03	Required
Lab Code	ESL-3053		ESL-4516	LLD
Location	E-05	E-12	E-05	
Ratio (wet wt./dry wt.)	2.85		4.26	
Gross Beta	5.94 ± 0.25	ND[a]	3.38 ± 0.28	0.25
Be-7	0.92 ± 0.19	-	1.91 ± 0.44	-
K-40	2.57 ± 0.33	-	1.80 ± 0.48	-
Co-58	0.003 ± 0.008	-	0.011 ± 0.014	0.25
Co-60	0.009 ± 0.009	-	0.009 ± 0.016	0.25
Cs-134	0.009 ± 0.009	-	-0.006 ± 0.017	0.25
Cs-137	0.025 ± 0.010	-	0.011 ± 0.017	0.25
Collection Date	08-07-03	08-28-03	08-28-03	
Lab Code	ESL-4517	ESL-4868	ESL-4869	
Location	E-12	E-05	E-12	
Ratio (wet wt./dry wt.)	4.74	4.46	6.06	
Gross Beta	2.91 ± 0.20	3.14 ± 0.21	1.78 ± 0.12	
Be-7	0.93 ± 0.41	0.41 ± 0.22	0.19 ± 0.13	
K-40	1.64 ± 0.47	1.63 ± 0.57	1.08 ± 0.49	
Co-58	-0.007 ± 0.015	0.007 ± 0.018	0.010 ± 0.015	
Co-60	0.010 ± 0.014	0.020 ± 0.025	-0.013 ± 0.022	
Cs-134	-0.009 ± 0.018	0.013 ± 0.022	0.008 ± 0.018	
Cs-137	0.004 ± 0.017	0.011 ± 0.025	-0.014 ± 0.018	
Collection Date	10-05-03	10-05-03		
Lab Code	ESL-5800	ESL-5801		
Location	E-05	E-12		
Ratio (wet wt./dry wt.)	3.61	2.20		
Gross Beta	3.23 ± 0.47	4.91 ± 0.84		
Be-7	0.98 ± 0.28	0.35 ± 0.12		
K-40	6.28 ± 0.31	1.62 ± 0.43		
Co-58	0.010 ± 0.014	-0.005 ± 0.011		
Co-60	0.005 ± 0.012	0.006 ± 0.014		
Cs-134	0.003 ± 0.014	0.000 ± 0.015		
Cs-137	0.010 ± 0.014	0.021 ± 0.014		

[a] "ND" = No data; sample not available.

POINT BEACH NUCLEAR PLANT

AMBIENT GAMMA RADIATION (TLD)
1st. Quarter, 2003

	Date Annealed:	12-17-02	Days in the field	98
	Date Placed:	12-26-02	Days from Annealing	
	Date Removed:	04-03-03	to Readout:	114
	Date Read:	04-10-03		

Location	Days in Field	Total mR	Net mR	Net mR per 7 days
Indicator				
E-1	98	14.1 ± 0.9	10.8 ± 1.0	0.77 ± 0.07
E-2	98	16.7 ± 0.1	13.4 ± 0.5	0.95 ± 0.03
E-3	98	19.4 ± 1.2	16.1 ± 1.3	1.15 ± 0.09
E-4	98	15.1 ± 1.2	11.8 ± 1.3	0.84 ± 0.09
E-5	98	18.4 ± 1.2	15.1 ± 1.3	1.08 ± 0.09
E-6	98	14.9 ± 0.7	11.6 ± 0.8	0.83 ± 0.06
E-7	98	15.5 ± 1.1	12.2 ± 1.2	0.87 ± 0.08
E-8	98	15.7 ± 1.4	12.4 ± 1.5	0.88 ± 0.10
E-9	98	18.5 ± 0.3	15.2 ± 0.5	1.08 ± 0.04
E-12	98	13.2 ± 0.3	9.9 ± 0.5	0.70 ± 0.04
E-14	98	17.2 ± 0.5	13.9 ± 0.7	0.99 ± 0.05
E-15	98	18.9 ± 0.5	15.6 ± 0.7	1.11 ± 0.05
E-16	98	16.7 ± 0.3	13.4 ± 0.5	0.95 ± 0.04
E-17	98	17.3 ± 0.6	14.0 ± 0.7	1.00 ± 0.05
E-18	98	18.3 ± 0.8	15.0 ± 0.9	1.07 ± 0.07
E-22	98	17.5 ± 1.2	14.2 ± 1.3	1.01 ± 0.09
E-23	98	17.6 ± 0.6	14.3 ± 0.7	1.02 ± 0.05
E-24	98	17.3 ± 1.4	14.0 ± 1.5	1.00 ± 0.10
E-25	98	15.4 ± 0.2	12.1 ± 0.5	0.86 ± 0.03
E-26	98	14.0 ± 0.2	10.7 ± 0.5	0.76 ± 0.03
E-27	98	16.7 ± 1.2	13.4 ± 1.3	0.95 ± 0.09
E-28	98	13.0 ± 0.3	9.7 ± 0.5	0.69 ± 0.04
E-29	98	14.7 ± 0.8	11.4 ± 0.9	0.81 ± 0.07
E-30	98	15.7 ± 0.8	12.4 ± 0.9	0.88 ± 0.07
E-31	98	17.6 ± 0.5	14.3 ± 0.7	1.02 ± 0.05
E-32	98	16.6 ± 0.7	13.3 ± 0.8	0.95 ± 0.06
E-38	98	16.9 ± 1.4	13.6 ± 1.5	0.97 ± 0.10
E-39	98	15.4 ± 0.4	12.1 ± 0.6	0.86 ± 0.04
Control				
E-20	98	15.7 ± 0.8	12.4 ± 0.9	0.88 ± 0.07
Mean±s.d.		16.3 ± 1.7	13.0 ± 1.7	0.93 ± 0.12

In-Transit Exposure

Date Annealed	12-17-02	03-13-03
Date Read	01-01-03	04-10-03
	Total mR	
ITC-1	3.2 ± 0.1	3.7 ± 0.3
ITC-2	2.9 ± 0.1	3.6 ± 0.3

POINT BEACH NUCLEAR PLANT

AMBIENT GAMMA RADIATION (TLD)
2nd Quarter, 2003

Date Annealed:	03-13-03	Days in the field	98
Date Placed:	04-03-03	Days from Annealing	
Date Removed:	07-10-03	to Readout:	127
Date Read:	07-18-03		

Location	Days in Field	Total mR	Net mR	Net mR per 7 days
Indicator				
E-1	98	16.6 ± 1.3	11.7 ± 1.4	0.83 ± 0.10
E-2	98	21.4 ± 1.6	16.5 ± 1.7	1.18 ± 0.12
E-3	98	22.5 ± 2.0	17.6 ± 2.1	1.25 ± 0.15
E-4	98	18.0 ± 0.5	13.1 ± 0.7	0.93 ± 0.05
E-5	98	20.1 ± 0.7	15.2 ± 0.9	1.08 ± 0.06
E-6	98	17.8 ± 0.5	12.9 ± 0.7	0.92 ± 0.05
E-7	98	15.7 ± 0.2	10.8 ± 0.6	0.77 ± 0.04
E-8	98	18.0 ± 0.8	13.1 ± 1.0	0.93 ± 0.07
E-9	98	20.9 ± 1.5	16.0 ± 1.6	1.14 ± 0.11
E-12	98	14.9 ± 1.0	10.0 ± 1.1	0.71 ± 0.08
E-14	98	19.5 ± 1.0	14.6 ± 1.1	1.04 ± 0.08
E-15	98	23.6 ± 0.4	18.7 ± 0.7	1.33 ± 0.05
E-16	98	18.5 ± 0.4	13.6 ± 0.7	0.97 ± 0.05
E-17	98	18.5 ± 1.0	13.6 ± 1.1	0.97 ± 0.08
E-18	98	20.4 ± 0.2	15.5 ± 0.6	1.10 ± 0.04
E-22	98	20.3 ± 0.7	15.4 ± 0.9	1.10 ± 0.06
E-23	98	21.2 ± 0.5	16.3 ± 0.7	1.16 ± 0.05
E-24	98	19.5 ± 0.9	14.6 ± 1.1	1.04 ± 0.08
E-25	98	21.1 ± 0.6	16.2 ± 0.8	1.15 ± 0.06
E-26	98	17.5 ± 0.7	12.6 ± 0.9	0.90 ± 0.06
E-27	98	19.6 ± 0.5	14.7 ± 0.7	1.05 ± 0.05
E-28	98	16.4 ± 0.6	11.5 ± 0.8	0.82 ± 0.06
E-29	98	17.4 ± 0.3	12.5 ± 0.6	0.89 ± 0.05
E-30	98	19.5 ± 0.5	14.6 ± 0.7	1.04 ± 0.05
E-31	98	22.1 ± 1.4	17.2 ± 1.5	1.23 ± 0.11
E-32	98	21.2 ± 1.2	16.3 ± 1.3	1.16 ± 0.09
E-38	98	18.8 ± 0.5	13.9 ± 0.7	0.99 ± 0.05
E-39	98	17.6 ± 0.4	12.7 ± 0.7	0.90 ± 0.05
Control				
E-20	98	18.5 ± 0.8	13.6 ± 1.0	0.97 ± 0.07
Mean±s.d.		19.2 ± 2.1	14.3 ± 2.1	1.02 ± 0.15

In-Transit Exposure[a]

Date Annealed	03-13-03	06-19-03
Date Read	04-10-03	07-21-03
	Total mR	
ITC-1	3.7 ± 0.3	6.3 ± 0.3
ITC-2	3.6 ± 0.3	6.2 ± 0.2

POINT BEACH NUCLEAR PLANT

AMBIENT GAMMA RADIATION (TLD)
3rd Quarter, 2003

	Date Annealed:	06-19-03	Days in the field	87
	Date Placed:	07-10-03	Days from Annealing	
	Date Removed:	10-05-03	to Readout:	116
	Date Read:	10-13-03		

Location	Days in Field	Total mR	Net mR	Net mR per 7 days
Indicator				
E-1	87	15.8 ± 1.1	11.2 ± 1.2	0.90 ± 0.10
E-2	87	17.5 ± 0.1	12.9 ± 0.5	1.04 ± 0.04
E-3	87	21.1 ± 1.4	16.5 ± 1.5	1.33 ± 0.12
E-4	87	16.9 ± 1.3	12.3 ± 1.4	0.99 ± 0.11
E-5	87	20.1 ± 1.1	15.5 ± 1.2	1.25 ± 0.10
E-6	87	16.6 ± 0.9	12.0 ± 1.0	0.97 ± 0.08
E-7	87	17.7 ± 1.0	13.1 ± 1.1	1.05 ± 0.09
E-8	87	17.3 ± 0.8	12.7 ± 0.9	1.02 ± 0.08
E-9	87	20.3 ± 0.7	15.7 ± 0.9	1.26 ± 0.07
E-12	87	14.2 ± 0.3	9.6 ± 0.6	0.77 ± 0.05
E-14	87	19.0 ± 0.4	14.4 ± 0.6	1.16 ± 0.05
E-15	87	20.5 ± 0.6	15.9 ± 0.8	1.28 ± 0.06
E-16	87	18.6 ± 0.5	14.0 ± 0.7	1.13 ± 0.06
E-17	87	19.4 ± 0.6	14.8 ± 0.8	1.19 ± 0.06
E-18	87	19.8 ± 1.0	15.2 ± 1.1	1.22 ± 0.09
E-22	87	19.2 ± 1.3	14.6 ± 1.4	1.17 ± 0.11
E-23	87	19.0 ± 0.3	14.4 ± 0.6	1.16 ± 0.05
E-24	87	19.7 ± 1.2	15.1 ± 1.3	1.21 ± 0.10
E-25	87	17.3 ± 0.3	12.7 ± 0.6	1.02 ± 0.05
E-26	87	16.2 ± 0.3	11.6 ± 0.6	0.93 ± 0.05
E-27	87	19.1 ± 1.2	14.5 ± 1.3	1.17 ± 0.10
E-28	87	16.0 ± 0.2	11.4 ± 0.5	0.92 ± 0.04
E-29	87	18.6 ± 1.0	14.0 ± 1.1	1.13 ± 0.09
E-30	87	18.5 ± 0.8	13.9 ± 0.9	1.12 ± 0.08
E-31	87	21.1 ± 0.6	16.5 ± 0.8	1.33 ± 0.06
E-32	87	21.2 ± 1.8	16.6 ± 1.9	1.34 ± 0.15
E-38	87	20.4 ± 0.8	15.8 ± 0.9	1.27 ± 0.08
E-39	87	18.1 ± 0.5	13.5 ± 0.7	1.09 ± 0.06
Control				
E-20	87	17.5 ± 0.9	12.9 ± 1.0	1.04 ± 0.08
Mean±s.d.		18.5 ± 1.8	13.9 ± 1.8	1.12 ± 0.14

In-Transit Exposure

Date Annealed	06-19-03	09-22-03
Date Read	07-21-03	10-14-03
	Total mR	
ITC-1	6.3 ± 0.3	2.9 ± 0.3
ITC-2	6.2 ± 0.2	3.0 ± 0.2

POINT BEACH NUCLEAR PLANT

AMBIENT GAMMA RADIATION (TLD)
4th Quarter, 2003

	Date Annealed:	09-22-03	Days in the field	96
	Date Placed:	10-05-03	Days from Annealing	
	Date Removed:	01-09-04	to Readout:	130
	Date Read:	01-30-04		

Location	Days in Field	Total mR	Net mR	Net mR per 7 days
Indicator				
E-1	96	18.5 ± 1.6	13.7 ± 1.8	1.00 ± 0.13
E-2	96	23.5 ± 1.5	18.7 ± 1.7	1.37 ± 0.12
E-3	96	24.6 ± 2.1	19.8 ± 2.2	1.45 ± 0.16
E-4	96	20.2 ± 0.6	15.4 ± 0.9	1.12 ± 0.07
E-5	96	22.2 ± 1.1	17.4 ± 1.3	1.27 ± 0.10
E-6	96	18.6 ± 0.5	13.8 ± 0.9	1.01 ± 0.06
E-7	96	18.7 ± 3.3	13.9 ± 3.4	1.02 ± 0.25
E-8	96	18.8 ± 0.8	14.0 ± 1.1	1.02 ± 0.08
E-9	96	21.4 ± 1.6	16.6 ± 1.8	1.21 ± 0.13
E-12	96	15.6 ± 1.1	10.8 ± 1.3	0.79 ± 0.10
E-14	96	20.0 ± 1.1	15.2 ± 1.3	1.11 ± 0.10
E-15	96	23.9 ± 0.3	19.1 ± 0.8	1.39 ± 0.06
E-16	96	19.0 ± 0.2	14.2 ± 0.8	1.04 ± 0.06
E-17	96	19.4 ± 1.1	14.6 ± 1.3	1.07 ± 0.10
E-18	96	22.9 ± 0.2	18.1 ± 0.8	1.32 ± 0.06
E-22	96	20.2 ± 1.5	15.4 ± 1.7	1.12 ± 0.12
E-23	96	21.8 ± 0.6	17.0 ± 0.9	1.24 ± 0.07
E-24	96	19.9 ± 0.6	15.1 ± 0.9	1.10 ± 0.07
E-25	96	20.6 ± 0.3	15.8 ± 0.8	1.15 ± 0.06
E-26	96	17.2 ± 0.4	12.4 ± 0.8	0.91 ± 0.06
E-27	96	19.0 ± 0.9	14.2 ± 1.2	1.04 ± 0.08
E-28	96	16.6 ± 0.4	11.8 ± 0.8	0.86 ± 0.06
E-29	96	17.5 ± 0.7	12.7 ± 1.0	0.93 ± 0.07
E-30	96	18.9 ± 0.4	14.1 ± 0.8	1.03 ± 0.06
E-31	96	21.5 ± 1.4	16.7 ± 1.6	1.22 ± 0.12
E-32	96	20.7 ± 1.2	15.9 ± 1.4	1.16 ± 0.10
E-38	96	18.9 ± 0.6	14.1 ± 0.9	1.03 ± 0.07
E-39	96	21.5 ± 0.5	16.7 ± 0.9	1.22 ± 0.06
Control				
E-20	96	19.5 ± 1.6	14.7 ± 1.8	1.07 ± 0.13
Mean±s.d.		20.0 ± 2.2	15.3 ± 2.2	1.11 ± 0.15

In-Transit Exposure

Date Annealed	09-22-03	12-15-03
Date Read	10-14-03	01-30-04
	Total mR	
ITC-1	2.9 ± 0.3	6.6 ± 0.6
ITC-2	3.0 ± 0.2	6.6 ± 0.2

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APPENDIX A

INTERLABORATORY COMPARISON PROGRAM RESULTS

NOTE: Environmental Inc., Midwest Laboratory participates in intercomparison studies administered by Environmental Resources Associates, and serves as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. Results are reported in Appendix A. TLD Intercomparison results, in-house spikes, blanks, duplicates and mixed analyte performance evaluation program results are also reported. Appendix A is updated four times a year; the complete Appendix is included in March, June, September and December monthly progress reports only.

January, 2003 through December, 2003

Appendix A

Interlaboratory Comparison Program Results

Environmental, Inc., Midwest Laboratory, formerly Teledyne Brown Engineering Environmental Services Midwest Laboratory has participated in interlaboratory comparison (crosscheck) programs since the formulation of it's quality control program in December 1971. These programs are operated by agencies which supply environmental type samples containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. The purpose of such a program is to provide an independent check on a laboratory's analytical procedures and to alert it of any possible problems.

Participant laboratories measure the concentration of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

Results in Table A-1 were obtained through participation in the environmental sample crosscheck program administered by Environmental Resources Associates, serving as a replacement for studies conducted previously by the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

The results in Table A-2 were obtained for Thermoluminescent Dosimeters (TLDs), via International Intercomparison of Environmental Dosimeters under the sponsorships listed in Table A-2. Results of internal laboratory testing is also listed.

Table A-3 lists results of the analyses on in-house "spiked" samples for the past twelve months. All samples are prepared using NIST traceable sources. Data for previous years available upon request.

Table A-4 lists results of the analyses on in-house "blank" samples for the past twelve months. Data for previous years available upon request. request.

Table A-5 list results of the in-house "duplicate" program for the past twelve months. Acceptance is based on the difference of the results being less than the sum of the errors. Data for previous years available upon request.

The results in Table A-6 were obtained through participation in the Mixed Analyte Performance Evaluation Program.

The results in Table A-7 were obtained through participation in the Environmental Measurement Laboratory Quality Assessment Program.

Attachment A lists acceptance criteria for "spiked" samples.

Out-of-limit results are explained directly below the result.

Attachment A

ACCEPTANCE CRITERIA FOR "SPIKED" SAMPLES

LABORATORY PRECISION: ONE STANDARD DEVIATION VALUES FOR VARIOUS ANALYSES[a]

Analysis	Level	One standard deviation for single determination
Gamma Emitters	5 to 100 pCi/liter or kg > 100 pCi/liter or kg	5.0 pCi/liter 5% of known value
Strontium-89[b]	5 to 50 pCi/liter or kg > 50 pCi/liter or kg	5.0 pCi/liter 10% of known value
Strontium-90[b]	2 to 30 pCi/liter or kg > 30 pCi/liter or kg	5.0 pCi/liter 10% of known value
Potassium-40	> 0.1 g/liter or kg	5% of known value
Gross alpha	20 pCi/liter > 20 pCi/liter	5.0 pCi/liter 25% of known value
Gross beta	100 pCi/liter > 100 pCi/liter	5.0 pCi/liter 5% of known value
Tritium	4,000 pCi/liter > 4,000 pCi/liter	1s = (pCi/liter) = $169.85 \times (\text{known})^{0.0933}$ 10% of known value
Radium-226,-228	0.1 pCi/liter	15% of known value
Plutonium	0.1 pCi/liter, gram, or sample	10% of known value
Iodine-131, Iodine-129[b]	55 pCi/liter > 55 pCi/liter	6.0 pCi/liter 10% of known value
Uranium-238, Nickel-63[b] Technetium-99[b]	35 pCi/liter > 35 pCi/liter	6.0 pCi/liter 15% of known value
Iron-55[b]	50 to 100 pCi/liter > 100 pCi/liter	10 pCi/liter 10% of known value
Others[b]	---	20% of known value

[a] From EPA publication, "Environmental Radioactivity Laboratory Intercomparison Studies Program, Fiscal Year, 1981-1982, EPA-600/4-81-004.

[b] Laboratory limit.

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result[b]	ERA Result[c]	Control Limits
STW-973	02/17/03	Sr-89	17.0 ± 0.5	15.9 ± 5.0	7.2 - 24.6
STW-973	02/17/03	Sr-90	8.9 ± 0.3	9.0 ± 5.0	0.4 - 17.7
STW-974	02/17/03	Ba-133	14.5 ± 0.9	19.5 ± 5.0	10.8 - 28.2
STW-974	02/17/03	Co-60	37.5 ± 0.9	37.4 ± 5.0	28.7 - 46.1
STW-974	02/17/03	Cs-134	18.2 ± 0.6	17.8 ± 5.0	9.1 - 26.5
STW-974	02/17/03	Cs-137	42.7 ± 1.0	44.2 ± 5.0	35.5 - 52.9
STW-974	02/17/03	Zn-65	56.8 ± 2.2	60.3 ± 6.0	49.9 - 70.7
STW-975[d]	02/17/03	Gr. Alpha	18.4 ± 0.3	37.6 ± 9.4	21.3 - 53.9
STW-975	02/17/03	Gr. Beta	11.7 ± 0.5	8.6 ± 5.0	0.0 - 17.2
STW-976	02/17/03	Ra-226	4.1 ± 0.1	4.7 ± 0.7	3.5 - 6.0
STW-976	02/17/03	Ra-228	7.6 ± 0.5	6.5 ± 1.6	3.7 - 9.3
STW-976	02/17/03	Uranium	52.9 ± 1.9	53.7 ± 5.4	44.4 - 63.0
STW-983	05/19/03	H-3	1290.0 ± 25.0	1250.0 ± 331.0	678.0 - 1820.0
STW-984	05/19/03	I-131	19.7 ± 1.3	20.8 ± 3.0	15.6 - 26.0
STW-985	05/19/03	Gr. Alpha	54.4 ± 3.0	70.3 ± 17.6	39.9 - 101.0
STW-985	05/19/03	Ra-226	14.9 ± 0.2	16.5 ± 2.5	12.2 - 20.8
STW-985	05/19/03	Ra-228	13.1 ± 0.6	10.3 ± 2.6	5.8 - 14.8
STW-985	05/19/03	Uranium	14.5 ± 0.4	15.1 ± 3.0	9.9 - 20.3
STW-986	05/19/03	Co-60	56.9 ± 8.6	63.8 ± 5.0	55.1 - 72.5
STW-986[e]	05/19/03	Cs-134	61.6 ± 6.6	75.7 ± 5.0	67.0 - 84.4
STW-986	05/19/03	Cs-137	143.0 ± 1.2	150.0 ± 7.5	137.0 - 163.0
STW-986	05/19/03	Gr. Beta	309.0 ± 2.7	363.0 ± 54.5	269.0 - 457.0
STW-986	05/19/03	Sr-89	33.1 ± 0.2	31.3 ± 5.0	22.6 - 40.0
STW-986	05/19/03	Sr-90	28.8 ± 1.3	27.4 ± 5.0	18.7 - 36.1
STW-988	08/18/03	Ra-226	13.3 ± 1.1	13.4 ± 2.0	9.9 - 16.9
STW-988	08/18/03	Ra-228	11.5 ± 1.0	12.5 ± 3.1	7.1 - 17.9
STW-988	08/18/03	Uranium	12.3 ± 0.4	11.4 ± 3.0	6.2 - 16.6
STW-989	08/18/03	Ba-133	18.1 ± 1.9	20.7 ± 5.0	12.0 - 29.4
STW-989	08/18/03	Co-60	35.9 ± 1.3	37.4 ± 5.0	28.7 - 46.1
STW-989	08/18/03	Cs-134	32.6 ± 1.8	32.6 ± 5.0	23.9 - 41.3
STW-989	08/18/03	Cs-137	48.3 ± 0.6	44.3 ± 5.0	35.6 - 53.0
STW-989	08/18/03	Zn-65	58.9 ± 2.1	60.2 ± 6.0	49.8 - 70.6
STW-990	08/18/03	Gr. Alpha	41.8 ± 3.4	56.2 ± 16.3	36.9 - 93.3
STW-990[f]	08/18/03	Gr. Beta	51.3 ± 3.0	31.6 ± 5.0	22.9 - 40.3
STW-991	08/18/03	Sr-89	57.2 ± 4.3	58.8 ± 5.0	50.1 - 67.5
STW-991	08/18/03	Sr-90	21.2 ± 0.9	20.6 ± 5.0	11.9 - 29.3

TABLE A-1. Interlaboratory Comparison Crosscheck program, Environmental Resource Associates (ERA)[a].

Lab Code	Date	Analysis	Concentration (pCi/L) Laboratory Result[b]	ERA Result[c]	Control Limits
STW-997	11/18/03	Gr. Alpha	37.0 ± 2.0	29.5 ± 7.4	16.7 - 42.3
STW-997	11/18/03	Gr. Beta	26.5 ± 0.8	26.3 ± 5.0	17.6 - 35.0
STW-998	11/18/03	I-131	14.8 ± 0.3	16.5 ± 3.0	11.3 - 21.7
STW-999	11/18/03	Ra-226	17.2 ± 1.1	17.8 ± 2.7	13.2 - 22.4
STW-999	11/18/03	Ra-228	6.6 ± 0.3	6.8 ± 1.7	3.8 - 9.7
STW-999	11/18/03	Uranium	11.7 ± 0.3	11.7 ± 3.0	6.5 - 16.9
STW-1000	11/18/03	H-3	15900.0 ± 174.0	14300.0 ± 1430.0	11800.0 - 16800.0
STW-1001	11/18/03	Gr. Alpha	32.9 ± 0.3	54.2 ± 3.0	30.7 - 77.7
STW-1001	11/18/03	Ra-226	16.5 ± 0.9	16.1 ± 2.4	11.9 - 20.3
STW-1001	11/18/03	Ra-228	6.2 ± 0.5	5.5 ± 1.4	3.1 - 7.9
STW-1001	11/18/03	Uranium	9.7 ± 1.5	9.3 ± 13.6	4.1 - 14.5
STW-1002	11/18/03	Co-60	27.7 ± 1.9	27.7 ± 5.0	19.0 - 36.4
STW-1002	11/18/03	Cs-134	21.5 ± 1.1	23.4 ± 5.0	17.6 - 29.2
STW-1002	11/18/03	Cs-137	66.3 ± 2.8	64.2 ± 5.0	55.5 - 72.9
STW-1002	11/18/03	Gr. Beta	159.0 ± 2.5	168.0 ± 5.0	124.0 - 212.0
STW-1002	11/18/03	Sr-89	48.5 ± 0.4	50.4 ± 5.0	41.7 - 59.1
STW-1002	11/18/03	Sr-90	10.1 ± 3.0	10.2 ± 25.2	1.5 - 18.9

[a] Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the environmental samples crosscheck program operated by Environmental Resources Associates (ERA).

[b] Unless otherwise indicated, the laboratory result is given as the mean ± standard deviation for three determinations.

[c] Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA.

[d] Recount of the original sample still low. The ERA blank was spiked in the lab; known value of 20.1 pCi/L, measured 21.5 ± 1.1 pCi/L. No explanation for ERA test failure.

[e] Lower bias observed for gamma spectroscopic analysis. The undiluted sample was reanalyzed; Results of reanalysis, Co-60: 62.3 pCi/L., Cs-134: 69.2 pCi/L., Cs-137: 152.3 pCi/L.

[f] Reason for deviation unknown. A recount of the original planchets averaged 43.4 pCi/L. Cs-137activity by gamma spectroscopy; 28.3 pCi/L. Result of reanalysis; 29.3 pCi/L.

TABLE A-2. Crosscheck program results; Thermoluminescent Dosimetry, (TLDs).

Lab Code	TLD Type	Date	Description	mR Known Value	mR Lab Result ± 2 sigma	mR Control Limits
Environmental, Inc.						
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 120	4.69	4.74 ± 0.54	3.28 - 6.10
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 150	3.00	3.02 ± 0.20	2.10 - 3.90
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 180	2.08	1.89 ± 0.45	1.46 - 2.70
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 180	2.08	2.11 ± 0.22	1.46 - 2.70
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 30	75.00	84.40 ± 4.87	52.50 - 97.50
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 60	18.75	19.11 ± 1.86	13.13 - 24.38
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 60	18.75	22.82 ± 5.41	13.13 - 24.38
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 90	8.33	9.05 ± 1.17	5.83 - 10.83
2003-1	CaSO4: Dy Cards	8/8/2003	Reader 1, 90	8.33	7.60 ± 1.08	5.83 - 10.83
Environmental, Inc.						
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 30	61.96	73.50 ± 2.58	43.37 - 80.55
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 60	15.49	19.70 ± 0.51	10.84 - 20.14
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 60	15.49	16.93 ± 1.37	10.84 - 20.14
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 90	6.88	8.06 ± 0.60	4.82 - 8.94
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 90	6.88	6.64 ± 0.58	4.82 - 8.94
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 120	3.87	4.39 ± 0.17	2.71 - 5.03
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 150	2.48	2.34 ± 0.18	1.74 - 3.22
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 150	2.48	2.51 ± 0.16	1.74 - 3.22
2003-2	CaSO4: Dy Cards	1/12/2004	Reader 1, 180	1.72	2.01 ± 0.13	1.20 - 2.24

TABLE A-3. In-House "Spike" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L)[a] Laboratory results 2s, n=1[b]	Known Activity	Control Limits[c]
SPW-356	water	1/2/2003	Sr-90	34.04 ± 1.57	30.93	24.74 - 37.12
W-10303	water	1/3/2003	Gr. Beta	63.24 ± 1.20	63.90	53.90 - 73.90
W-11303	water	1/13/2003	Gr. Beta	59.75 ± 1.10	63.90	53.90 - 73.90
W-12103	water	1/21/2003	Gr. Beta	61.56 ± 1.59	63.99	53.99 - 73.99
SPAP-446	Air Filter	1/31/2003	Gr. Beta	1.49 ± 0.02	1.52	-8.48 - 11.52
SPW-468	water	1/31/2003	H-3	95982.00 ± 865.00	89607.00	71685.60 - 107528.40
W-20703	water	2/7/2003	Fe-55	9095.00 ± 114.00	10587.00	8469.60 - 12704.40
SPU-1347	Urine	3/1/2003	H-3	1724.00 ± 412.00	1784.33	1101.27 - 2467.39
DW-30303	water	3/3/2003	Gr. Beta	65.44 ± 0.59	63.90	53.90 - 73.90
SPCH-964	Charcoal	3/8/2003	I-131(G)	73.37 ± 0.28	69.45	59.45 - 79.45
SPMI-1086	Milk	3/13/2003	Cs-137	57.18 ± 8.03	49.50	39.50 - 59.50
SPMI-1086	Milk	3/13/2003	I-131	75.13 ± 12.01	67.60	54.08 - 81.12
SPMI-1086	Milk	3/13/2003	I-131(G)	65.81 ± 1.06	67.56	57.56 - 77.56
SPW-1088	water	3/13/2003	Co-60	27.16 ± 4.79	28.20	18.20 - 38.20
SPW-1088	water	3/13/2003	Cs-137	51.74 ± 9.15	49.50	39.50 - 59.50
SPW-1088	water	3/13/2003	I-131(G)	68.14 ± 12.92	67.60	57.60 - 77.60
SPW-1088	water	3/13/2003	I-131	76.94 ± 1.13	67.56	54.05 - 81.07
SPVE-1110	Vegetation	3/14/2003	I-131(G)	122.80 ± 16.80	124.00	111.60 - 136.40
SPW-1194	water	3/21/2003	Co-60	31.09 ± 6.28	28.15	18.15 - 38.15
SPW-1194	water	3/21/2003	Cs-137	55.11 ± 0.13	49.50	39.50 - 59.50
SPW-1194	water	3/21/2003	I-131(G)	66.17 ± 9.15	67.60	57.60 - 77.60
W-32103	water	3/21/2003	C-14	5201.00 ± 16.60	4966.00	2979.60 - 6952.40
SPCH-1429	Charcoal	4/1/2003	I-131(G)	8.83 ± 0.11	9.18	-0.82 - 19.18
W-40103	water	4/1/2003	Gr. Beta	67.74 ± 0.52	63.39	53.39 - 73.39
SPF-1407	Fish	4/2/2003	Cs-134	0.58 ± 0.03	0.59	0.35 - 0.83
SPF-1407	Fish	4/2/2003	Cs-137	1.29 ± 0.06	1.32	0.79 - 1.85
SPAP-1409	Air Filter	4/2/2003	Gr. Beta	1.44 ± 0.02	1.51	-8.49 - 11.51
SPU-41203	Urine	4/12/2003	H-3	1798.50 ± 409.30	1784.33	1101.27 - 2467.39
SPU-41703	Urine	4/17/2003	H-3	1625.10 ± 401.30	1784.33	1101.27 - 2467.39
SPW-2022	water	4/25/2003	H-3	89007.00 ± 798.00	88463.00	70770.40 - 106155.60
SPW-2053	water	4/28/2003	Cs-137	45.70 ± 9.44	49.35	39.35 - 59.35
SPW-2053	water	4/28/2003	Sr-90	47.51 ± 1.87	44.47	35.58 - 53.36
SPMI-2055	Milk	4/28/2003	Cs-137	61.65 ± 7.17	65.80	55.80 - 75.80
SPMI-2055	Milk	4/28/2003	Sr-90	38.45 ± 1.59	44.74	35.79 - 53.69
W-50603	water	5/6/2003	Gr. Beta	70.95 ± 0.53	63.39	53.39 - 73.39
W-60303	water	6/3/2003	Gr. Beta	63.00 ± 0.51	65.73	55.73 - 75.73
SPW-3960	water	7/15/2003	H-3	88700.00 ± 822.00	87369.00	69895.20 - 104842.80
SPMI-4019	Milk	7/18/2003	Cs-137	47.17 ± 7.22	49.11	39.11 - 59.11
SPMI-4019	Milk	7/18/2003	Sr-89	40.95 ± 4.88	49.49	39.49 - 59.49
SPMI-4019	Milk	7/18/2003	Sr-90	45.30 ± 1.73	44.24	35.39 - 53.09
SPW-4023	water	7/18/2003	Cs-137	51.92 ± 6.24	49.11	39.11 - 59.11
SPW-4023	water	7/18/2003	Sr-89	42.49 ± 10.23	49.49	39.49 - 59.49
SPW-4023	water	7/18/2003	Sr-90	49.69 ± 3.04	44.24	35.39 - 53.09
SPW-4518	water	8/8/2003	Fe-55	8176.00 ± 107.00	9330.00	7464.00 - 11196.00

TABLE A-3. In-House "Spike" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L) Laboratory results 2s, n=1[b]	Known Activity	Control Limits[c]
SPW-6197	water	10/16/2003	Tc-99	540.14 ± 54.00	539.73	377.81 - 701.65
SPAP-3958	Air Filter	10/28/2003	Gr. Beta	1.45 ± 0.02	1.50	-8.50 - 11.50
SPW-6401	water	10/28/2003	H-3	84867.00 ± 826.00	85984.00	68787.20 - 103180.80
SPAP-6403	Air Filter	10/28/2003	Gr. Beta	1.71 ± 0.02	1.49	-8.51 - 11.49
SPF-6418	Fish	10/28/2003	Cs-134	0.50 ± 0.02	0.49	0.29 - 0.69
SPF-6418	Fish	10/28/2003	Cs-137	1.37 ± 0.05	1.30	0.78 - 1.82
SPW-6421	water	10/28/2003	Fe-55	104.18 ± 1.26	88.18	68.18 - 108.18
SPMI-7459	Milk	12/12/2003	Cs-134	41.06 ± 2.45	41.88	31.88 - 51.88
SPMI-7459	Milk	12/12/2003	Cs-137	48.48 ± 4.99	48.64	38.64 - 58.64
SPMI-7459	Milk	12/12/2003	Sr-89	55.94 ± 4.12	65.80	52.64 - 78.96
SPMI-7459	Milk	12/12/2003	Sr-90	41.86 ± 1.57	43.80	35.04 - 52.56
SPW-7461	water	12/12/2003	Cs-134	44.07 ± 1.49	41.88	31.88 - 51.88
SPW-7461	water	12/12/2003	Cs-137	50.26 ± 2.67	48.64	38.64 - 58.64
SPW-7461	water	12/12/2003	Sr-89	56.41 ± 4.87	65.80	52.64 - 78.96
SPW-7461	water	12/12/2003	Sr-90	48.44 ± 1.84	43.80	35.04 - 52.56

[c] Control limits are based on Attachment A, Page A2 of this report.

NOTE: For fish, Jello is used for the Spike matrix. For Vegetation, cabbage is used for the Spike matrix.

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L)[a] Laboratory results (4.66σ) LLD	Activity[b]	Acceptance Criteria (4.66 σ)
SPW-357	water	1/2/2003	Sr-90	0.50	0.12 ± 0.25	1
W-10303	water	1/3/2003	Gr. Beta	0.12	0.022 ± 0.10	3.2
W-11303	water	1/13/2003	Gr. Beta	0.14	0.035 ± 0.10	3.2
W-12103	water	1/21/2003	Gr. Beta	0.12	0.029 ± 0.09	3.2
SPAP-447	Air Filter	1/31/2003	Gr. Beta	0.00	-0.0034 ± 0.00	3.2
SPW-469	water	1/31/2003	H-3	160.20	19.3 ± 80.30	200
W-20103	water	2/1/2003	Gr. Beta	0.17	0.0 ± 0.12	3.2
W-20703	water	2/7/2003	Fe-55	802.00	149 ± 498.00	1000
DW-30303		3/3/2003	Gr. Beta	0.15	0.007 ± 0.11	3.2
SPCH-965	Charcoal Cani	3/8/2003	I-131(G)	0.01		9.6
SPMI-1087	Milk	3/13/2003	Cs-134	7.49		10
SPMI-1087	Milk	3/13/2003	Cs-137	7.90		10
SPMI-1087	Milk	3/13/2003	I-131	0.33	-0.013 ± 0.18	0.5
SPMI-1087	Milk	3/13/2003	I-131(G)	7.76		20
SPW-1089	water	3/13/2003	Co-60	4.48		10
SPW-1089	water	3/13/2003	Cs-134	5.60		10
SPW-1089	water	3/13/2003	Cs-137	4.32		10
SPW-1089	water	3/13/2003	I-131	0.29	-0.050 ± 0.16	0.5
SPVE-1111	Vegetation	3/14/2003	I-131(G)	7.53		20
W-32103	water	3/21/2003	C-14	17.50	-0.4 ± 9.200	200
SPCH-1430	Charcoal Cani	4/1/2003	I-131(G)	0.01		9.6
W-40103	water	4/1/2003	Gr. Beta	0.14	-0.11 ± 0.100	3.2
SPF-1408	Fish	4/2/2003	Cs-134	0.01		100
SPF-1408	Fish	4/2/2003	Cs-137	0.01		100
SPAP-1410	Air Filter	4/2/2003	Gr. Beta	0.00	-0.0029 ± 0.002	3.2
SPU-41203	Urine	4/12/2003	H-3	653.99	542.28 ± 364.780	200
SPU-41703	Urine	4/17/2003	H-3	648.35	100.1 ± 344.800	200
SPW-2054	water	4/28/2003	Cs-137	3.16		10
SPW-2054	water	4/28/2003	Sr-89	0.55	0.45 ± 0.50	5
SPW-2054	water	4/28/2003	Sr-90	0.55	0.072 ± 0.260	1
SPMI-2056 [c]	Milk	4/28/2003	Sr-90	0.77	0.66 ± 0.430	1
SPMI-2056	Milk	4/28/2003	Cs-137	2.74		10
SPMI-2056	Milk	4/28/2003	I-131(G)	3.54		20
W-50603	water	5/6/2003	Gr. Beta	0.12	0 ± 0.090	3.2
W-60303	water	6/3/2003	Gr. Beta	0.14	-0.035 ± 0.095	3.2
SPW-3960	water	7/15/2003	H-3	156.60	53.4 ± 80.200	200
SPMI-4018	Milk	7/18/2003	Cs-137	4.10		10
SPMI-4018	Milk	7/18/2003	Sr-89	0.73	0.39 ± 0.880	5
SPMI-4018 [c]	Milk	7/18/2003	Sr-90	0.51	0.93 ± 0.340	1
SPW-4024	water	7/18/2003	Sr-89	0.83	0.21 ± 0.730	5
SPW-4024	water	7/18/2003	Sr-90	0.62	0.09 ± 0.300	1
SPW-4519	water	8/8/2003	Fe-55	527.00	87 ± 369.000	1000
SPW-6401	water	10/28/2003	H-3	163.80	-23.8 ± 85.000	200

TABLE A-4. In-House "Blank" Samples

Lab Code	Sample Type	Date	Analysis	Concentration (pCi/L)[a]		
				Laboratory results (4.66σ)		Acceptance Criteria (4.66 σ)
				LLD	Activity[b]	
SPAP-6404	Air Filter	10/28/2003	Gr. Beta	0.87	-0.99 ± 0.440	3.2
SPF-6419	Fish	10/28/2003	Cs-134	0.01		100
SPF-6419	Fish	10/28/2003	Cs-137	0.01		100
SPMI-7460	Milk	12/12/2003	Cs-134	4.52		10
SPMI-7460	Milk	12/12/2003	Cs-137	5.77		10
SPMI-7460[c]	Milk	12/12/2003	Sr-90	0.50	1.26 ± 0.370	1

[a] Liquid sample results are reported in pCi/Liter, air filters(pCi/filter), charcoal (pCi/charcoal canister), and solid samples (pCi/kg).
[b] The activity reported is the net activity result.
[c] Low levels of Sr-90 are still detected in the environment. A concentration of (1-5 pCi/L) in milk is not unusual.

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result
MI-24, 25	1/2/2003	K-40	1362.00 ± 117.00	1377.00 ± 188.00	1369.50 ± 110.72
MI-24, 25	1/2/2003	Sr-90	1.45 ± 0.40	2.21 ± 0.50	1.83 ± 0.32
CF-47, 48	1/2/2003	Gr. Beta	2.72 ± 0.10	2.84 ± 0.10	2.78 ± 0.07
CF-47, 48	1/2/2003	K-40	2.61 ± 0.31	2.32 ± 0.12	2.47 ± 0.17
AP-8827, 8828	1/2/2003	Be-7	0.06 ± 0.01	0.05 ± 0.02	0.05 ± 0.01
AP-8869, 8870	1/2/2003	Be-7	0.04 ± 0.02	0.05 ± 0.02	0.05 ± 0.01
MI-119, 120	1/8/2003	K-40	1351.90 ± 116.10	1234.70 ± 108.70	1293.30 ± 79.52
MI-119, 120	1/8/2003	Sr-90	2.22 ± 0.43	1.88 ± 0.40	2.05 ± 0.30
MI-213, 214	1/14/2003	K-40	1372.30 ± 104.80	1303.80 ± 109.10	1338.05 ± 75.64
MI-213, 214	1/14/2003	Sr-90	1.81 ± 0.41	2.29 ± 0.45	2.05 ± 0.31
MI-262, 263	1/15/2003	K-40	1399.20 ± 200.70	1347.70 ± 126.40	1373.45 ± 118.59
S-696, 697	1/29/2003	Gr. Alpha	24.70 ± 4.89	23.23 ± 4.64	23.97 ± 3.37
S-696, 697	1/29/2003	Gr. Beta	22.89 ± 2.67	22.71 ± 2.73	22.80 ± 1.91
MI-448, 449	2/3/2003	K-40	1159.70 ± 157.90	1396.40 ± 106.20	1278.05 ± 95.15
SW-470, 471	2/3/2003	Gr. Beta	13.62 ± 1.23	15.21 ± 1.21	14.42 ± 0.86
SW-470, 471	2/3/2003	K-40 (ICP)	5.10 ± 0.51	5.20 ± 0.52	5.15 ± 0.36
SW-470, 471	2/3/2003	K-40	5.80 ± 0.51	5.90 ± 0.52	5.85 ± 0.36
MI-517, 518	2/4/2003	K-40	1437.70 ± 125.50	1357.70 ± 188.00	1397.70 ± 113.02
MI-541, 542	2/5/2003	K-40	1443.00 ± 194.80	1385.20 ± 190.10	1414.10 ± 136.09
MI-620, 621	2/11/2003	K-40	1294.70 ± 115.10	1234.10 ± 165.10	1264.40 ± 100.63
DW-922, 923	3/4/2003	I-131	0.67 ± 0.16	0.79 ± 0.16	0.73 ± 0.11
CF-1048, 1049 b	3/10/2003	K-40	3.09 ± 0.12	2.67 ± 0.07	2.88 ± 0.07
LW-1152, 1153	3/13/2003	H-3	1147.26 ± 122.56	1094.42 ± 120.92	1120.84 ± 86.09
F-1120, 1121	3/14/2003	Cs-137	0.04 ± 0.02	0.05 ± 0.01	0.05 ± 0.01
F-1120, 1121	3/14/2003	Gr. Beta	2.04 ± 0.06	2.11 ± 0.06	2.08 ± 0.04
F-1120, 1121	3/14/2003	K-40	1.93 ± 0.38	1.89 ± 0.25	1.91 ± 0.23
DW-1278, 1279	3/25/2003	I-131	0.37 ± 0.22	0.34 ± 0.29	0.36 ± 0.18
SO-1380, 1381	3/25/2003	Gr. Beta	18.60 ± 2.68	20.53 ± 2.83	19.57 ± 1.95
LW-1299, 1300	3/27/2003	Gr. Beta	2.35 ± 0.55	2.48 ± 0.56	2.42 ± 0.39
LW-1320, 1321	3/27/2003	H-3	487.12 ± 104.43	422.00 ± 102.00	454.56 ± 72.99
W-1403, 1404	3/31/2003	Sr-90	0.96 ± 0.32	1.10 ± 0.42	1.03 ± 0.26
AP-2019, 2020	3/31/2003	Be-7	0.07 ± 0.01	0.08 ± 0.01	0.07 ± 0.01
MI-1422, 1423	4/1/2003	K-40	1410.00 ± 176.00	1340.00 ± 114.00	1375.00 ± 104.85
MI-2170, 2171	4/1/2003	K-40	1452.30 ± 129.10	1472.50 ± 191.00	1462.40 ± 115.27
MI-1422, 1423	4/2/2003	Sr-90	1.84 ± 0.42	1.15 ± 0.39	1.50 ± 0.29
AP-1633, 1634	4/2/2003	Be-7	0.05 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
AP-1871, 1872	4/2/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-1974, 1975	4/2/2003	Be-7	0.08 ± 0.02	0.07 ± 0.02	0.08 ± 0.01
LW-1828, 1829	4/11/2003	Gr. Beta	2.49 ± 0.58	3.42 ± 0.63	2.96 ± 0.43
S-1544, 1545	4/15/2003	K-40	15.84 ± 2.36	15.41 ± 2.02	15.63 ± 1.55
DW-1913, 1914	4/15/2003	I-131	0.29 ± 0.21	0.42 ± 0.19	0.36 ± 0.14
MI-1996, 1997	4/21/2003	Sr-90	2.05 ± 0.74	3.25 ± 0.91	2.65 ± 0.58
MI-1996, 1997	4/22/2003	K-40	1580.20 ± 118.90	1602.10 ± 120.40	1591.15 ± 84.61

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result
LW-2063, 2064	4/28/2003	Gr. Beta	2.33 ± 0.66	2.68 ± 0.60	2.51 ± 0.45
SWU-2275, 2276	4/28/2003	Gr. Beta	3.62 ± 0.67	4.60 ± 0.71	4.11 ± 0.49
G-2149, 2150	4/30/2003	Be-7	0.71 ± 0.19	0.69 ± 0.20	0.70 ± 0.14
TD-2339, 2340	5/1/2003	H-3	221.00 ± 91.00	161.00 ± 88.00	191.00 ± 63.29
SO-2381, 2382	5/1/2003	Cs-137	0.11 ± 0.03	0.10 ± 0.02	0.10 ± 0.02
SO-2381, 2382	5/1/2003	Gr. Alpha	11.14 ± 5.15	10.39 ± 5.60	10.77 ± 3.80
SO-2381, 2382	5/1/2003	Gr. Beta	35.18 ± 4.69	39.66 ± 5.24	37.42 ± 3.52
SO-2381, 2382	5/1/2003	K-40	18.29 ± 0.84	17.83 ± 0.84	18.06 ± 0.59
SO-2381, 2382	5/1/2003	Sr-90	0.06 ± 0.02	0.10 ± 0.02	0.08 ± 0.01
DW-2317, 2318	5/6/2003	I-131	1.77 ± 0.27	1.47 ± 0.26	1.62 ± 0.19
BS-2595, 2596	5/6/2003	Cs-137	0.06 ± 0.02	0.06 ± 0.02	0.06 ± 0.02
BS-2595, 2596	5/6/2003	K-40	13.74 ± 0.62	14.10 ± 0.73	13.92 ± 0.48
U-2484, 2485	5/9/2003	H-3	512.00 ± 100.00	370.00 ± 95.00	441.00 ± 68.97
SO-2645, 2646	5/14/2003	Be-7	1.18 ± 0.42	1.21 ± 0.35	1.19 ± 0.27
SO-2645, 2646	5/14/2003	Cs-137	0.11 ± 0.04	0.09 ± 0.05	0.10 ± 0.03
SO-2645, 2646	5/14/2003	K-40	16.50 ± 1.13	15.33 ± 1.09	15.91 ± 0.79
MI-2696, 2697	5/19/2003	K-40	1320.40 ± 124.50	1394.10 ± 113.00	1357.25 ± 84.07
MI-2696, 2697	5/19/2003	Sr-90	1.49 ± 0.47	2.01 ± 0.45	1.75 ± 0.32
SO-2787, 2788	5/28/2003	Cs-137	0.27 ± 0.04	0.23 ± 0.04	0.25 ± 0.03
SO-2787, 2788	5/28/2003	Gr. Beta	19.62 ± 1.73	20.81 ± 1.72	20.21 ± 1.22
SO-2787, 2788	5/28/2003	K-40	14.77 ± 1.02	14.41 ± 1.00	14.59 ± 0.71
MI-2840, 2841	5/28/2003	K-40	1179.50 ± 167.80	1401.70 ± 120.20	1290.60 ± 103.20
SWU-2864, 2865	5/28/2003	Gr. Beta	3.39 ± 0.59	3.41 ± 0.64	3.40 ± 0.43
BS-2888, 2889	5/29/2003	Cs-137	0.05 ± 0.02	0.07 ± 0.04	0.06 ± 0.02
BS-2888, 2889	5/29/2003	K-40	9.70 ± 0.83	10.17 ± 0.87	9.93 ± 0.60
W-3230, 3231	5/30/2003	Gr. Beta	4.33 ± 1.00	3.28 ± 1.22	3.81 ± 0.79
TD-3036, 3037	6/2/2003	H-3	529.50 ± 100.00	585.50 ± 102.00	557.50 ± 71.42
SL-2909, 2910 b	6/3/2003	Gr. Beta	7.10 ± 0.15	7.60 ± 0.16	7.35 ± 0.11
SL-2909, 2910	6/3/2003	K-40	3.90 ± 0.67	3.49 ± 0.52	3.70 ± 0.42
SW-3080, 3081	6/10/2003	Gr. Alpha	4.63 ± 1.90	4.47 ± 1.71	4.55 ± 1.28
SW-3080, 3081	6/10/2003	Gr. Beta	9.07 ± 1.29	8.98 ± 1.28	9.02 ± 0.91
VE-3172, 3173	6/11/2003	K-40	2.62 ± 0.35	3.17 ± 0.58	2.90 ± 0.34
F-3742, 3743	6/11/2003	Gr. Beta	3.47 ± 0.13	3.71 ± 0.14	3.59 ± 0.10
F-3742, 3743	6/11/2003	K-40	2.94 ± 0.39	2.70 ± 0.40	2.82 ± 0.28
SO-3325, 3326	6/13/2003	Gr. Beta	20.95 ± 1.88	19.97 ± 2.01	20.46 ± 1.38
MI-3253, 3254	6/17/2003	K-40	1329.40 ± 121.80	1417.60 ± 130.90	1373.50 ± 89.40
MI-3297, 3298	6/17/2003	Sr-90	2.14 ± 0.57	2.27 ± 0.50	2.21 ± 0.38
WW-3380, 3381	6/23/2003	Gr. Beta	5.58 ± 0.69	5.03 ± 0.69	5.31 ± 0.49
SWT-3403, 3404	6/24/2003	Gr. Beta	2.80 ± 0.56	2.63 ± 0.55	2.72 ± 0.39
MI-3424, 3425	6/24/2003	K-40	1422.80 ± 185.40	1216.20 ± 170.10	1319.50 ± 125.80
SW-3862, 3863	6/24/2003	Gr. Beta	3.66 ± 1.18	3.70 ± 1.22	3.68 ± 0.85
G-3479, 3480	6/25/2003	Be-7	1.52 ± 0.25	1.43 ± 0.28	1.47 ± 0.19
G-3479, 3480	6/25/2003	K-40	5.02 ± 0.45	5.10 ± 0.48	5.06 ± 0.33
LW-3809, 3810	6/30/2003	Gr. Beta	2.12 ± 0.76	2.39 ± 0.72	2.25 ± 0.52

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result
LW-3809, 3810	6/30/2003	H-3	2814.09 ± 167.99	2812.17 ± 167.94	2813.13 ± 118.77
AP-4105, 4106	6/30/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
G-3572, 3573	7/1/2003	Be-7	0.91 ± 0.24	0.81 ± 0.28	0.86 ± 0.18
G-3572, 3573	7/1/2003	Gr. Beta	6.35 ± 0.15	6.35 ± 0.15	6.35 ± 0.11
G-3572, 3573	7/1/2003	K-40	5.44 ± 0.55	5.68 ± 0.28	5.56 ± 0.31
G-3572, 3573	7/1/2003	Sr-90	0.01 ± 0.00	0.02 ± 0.00	0.01 ± 0.00
MI-3601, 3602	7/1/2003	K-40	1318.60 ± 117.40	1435.10 ± 117.80	1376.85 ± 83.16
MI-3601, 3602	7/1/2003	Sr-90	0.86 ± 0.51	1.74 ± 0.60	1.30 ± 0.39
AP-3933, 3934	7/1/2003	Be-7	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-4061, 4062	7/2/2003	Be-7	0.07 ± 0.01	0.08 ± 0.01	0.08 ± 0.01
AP-4147, 4148	7/2/2003	Be-7	0.08 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
AP-4084, 4085	7/3/2003	Be-7	0.09 ± 0.02	0.08 ± 0.02	0.08 ± 0.01
LW-3786, 3787	7/9/2003	Gr. Beta	2.13 ± 0.56	2.93 ± 0.62	2.53 ± 0.42
WW-4168, 4169	7/11/2003	Gr. Beta	3.79 ± 1.87	4.48 ± 1.98	4.14 ± 1.36
CF-3975, 3976	7/14/2003	Be-7	1.64 ± 0.81	1.66 ± 0.57	1.65 ± 0.50
CF-3975, 3976	7/14/2003	K-40	6.54 ± 0.75	6.19 ± 0.50	6.36 ± 0.45
MI-4020, 4021	7/16/2003	K-40	1350.90 ± 174.90	1199.80 ± 153.20	1275.35 ± 116.25
DW-4272, 4273	7/29/2003	Gr. Beta	2.35 ± 0.92	2.29 ± 0.89	2.32 ± 0.64
SWU-4461, 4462	7/30/2003	Gr. Beta	2.28 ± 0.44	1.93 ± 0.43	2.10 ± 0.31
SL-4398, 4399	8/4/2003	Be-7	4.55 ± 1.05	4.50 ± 1.10	4.53 ± 0.76
SL-4398, 4399 b	8/4/2003	Gr. Beta	3.41 ± 0.12	3.12 ± 0.11	3.27 ± 0.08
SL-4398, 4399	8/4/2003	K-40	2.47 ± 0.67	2.44 ± 0.87	2.46 ± 0.55
G-4419, 4420	8/4/2003	Be-7	3.98 ± 0.63	3.93 ± 0.57	3.96 ± 0.42
G-4419, 4420	8/4/2003	Gr. Beta	5.38 ± 0.14	5.35 ± 0.16	5.37 ± 0.11
G-4419, 4420	8/4/2003	K-40	4.42 ± 0.66	4.32 ± 0.74	4.37 ± 0.50
TD-4550, 4551	8/4/2003	H-3	327.30 ± 95.10	390.20 ± 92.10	358.75 ± 66.19
MI-4482, 4483	8/6/2003	K-40	1301.40 ± 115.20	1370.30 ± 116.80	1335.85 ± 82.03
MI-4482, 4483	8/6/2003	Sr-90	0.81 ± 0.30	0.85 ± 0.31	0.83 ± 0.21
G-4526, 4527	8/6/2003	Be-7	1.47 ± 0.29	1.42 ± 0.28	1.45 ± 0.20
G-4526, 4527	8/6/2003	K-40	5.42 ± 0.56	5.21 ± 0.63	5.31 ± 0.42
SWU-4609, 4610	8/6/2003	Gr. Beta	3.22 ± 0.63	2.67 ± 0.64	2.95 ± 0.45
CW-4694, 4695	8/6/2003	Gr. Beta	1.48 ± 0.34	1.09 ± 0.34	1.29 ± 0.24
CW-4694, 4695	8/6/2003	H-3	22776.41 ± 428.73	21831.75 ± 420.10	22304.08 ± 300.12
LW-4673, 4674	8/13/2003	Gr. Beta	2.86 ± 0.65	3.75 ± 0.71	3.30 ± 0.48
MI-4735, 4736	8/19/2003	K-40	1396.30 ± 127.90	1410.10 ± 120.20	1403.20 ± 87.76
MI-4756, 4757	8/19/2003	Sr-90	1.66 ± 0.47	1.53 ± 0.44	1.60 ± 0.32
VE-4832, 4833	8/20/2003	K-40	1.96 ± 0.50	1.43 ± 0.47	1.70 ± 0.34
MI-4860, 4861	8/26/2003	K-40	1312.10 ± 191.80	1307.80 ± 109.30	1309.95 ± 110.38
SO-5082, 5083	8/28/2003	Cs-137	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
SO-5082, 5083	8/28/2003	Gr. Beta	20.02 ± 1.84	20.92 ± 2.03	20.47 ± 1.37
CW-5349, 5350	8/31/2003	Gr. Beta	1.45 ± 0.39	1.55 ± 0.45	1.50 ± 0.30
CW-5349, 5350	8/31/2003	H-3	24429.50 ± 444.42	24744.25 ± 447.18	24586.88 ± 315.23
ME-4968, 4969	9/2/2003	Gr. Beta	4.90 ± 0.23	5.18 ± 0.24	5.04 ± 0.17
ME-4968, 4969	9/2/2003	K-40	2.46 ± 0.41	2.68 ± 0.37	2.57 ± 0.28

TABLE A-5. *In-House "Duplicate" Samples*

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result
DW-4989, 4990	9/2/2003	Gr. Beta	2.20 ± 1.04	3.19 ± 1.14	2.70 ± 0.77
MI-5154, 5155	9/8/2003	K-40	1365.50 ± 116.70	1456.70 ± 119.10	1411.10 ± 83.37
MI-5154, 5155	9/8/2003	Sr-90	1.19 ± 0.39	1.39 ± 0.39	1.29 ± 0.28
AP-6177, 6178	9/29/2003	Be-7	0.07 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
SWU-5773, 5774	9/30/2003	Gr. Beta	2.55 ± 0.63	2.83 ± 0.60	2.69 ± 0.44
AP-6102, 6103	9/30/2003	Be-7	0.07 ± 0.01	0.05 ± 0.01	0.06 ± 0.01
G-5631, 5632	10/1/2003	Be-7	1.88 ± 0.48	2.21 ± 0.40	2.05 ± 0.31
G-5631, 5632	10/1/2003	Gr. Beta	5.87 ± 0.09	5.85 ± 0.08	5.86 ± 0.06
G-5631, 5632	10/1/2003	K-40	5.24 ± 0.77	5.26 ± 0.58	5.25 ± 0.48
SO-5660, 5661	10/1/2003	Cs-137	0.15 ± 0.04	0.16 ± 0.05	0.16 ± 0.03
SO-5660, 5661	10/1/2003	Gr. Alpha	12.72 ± 3.72	14.86 ± 3.88	13.79 ± 2.69
SO-5660, 5661	10/1/2003	Gr. Beta	32.42 ± 3.09	33.60 ± 3.04	33.01 ± 2.17
SO-5660, 5661	10/1/2003	K-40	18.93 ± 0.87	18.25 ± 1.19	18.59 ± 0.74
SO-5660, 5661	10/1/2003	Sr-90	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01
AP-6334, 6335	10/1/2003	Be-7	0.06 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
AP-6363, 6364	10/2/2003	Be-7	0.07 ± 0.02	0.07 ± 0.02	0.07 ± 0.01
MI-5794, 5795	10/6/2003	Sr-90	1.37 ± 0.37	1.02 ± 0.37	1.19 ± 0.26
MI-5838, 5839	10/8/2003	K-40	1364.30 ± 124.10	1414.40 ± 110.40	1389.35 ± 83.05
MI-5838, 5839	10/8/2003	Sr-90	0.76 ± 0.30	1.00 ± 0.34	0.88 ± 0.23
BS-5938, 5939	10/8/2003	Cs-137	0.18 ± 0.03	0.20 ± 0.05	0.19 ± 0.03
BS-5938, 5939	10/8/2003	K-40	15.59 ± 0.70	16.69 ± 0.80	16.14 ± 0.53
SS-5959, 5960	10/13/2003	K-40	7.49 ± 0.42	7.29 ± 0.63	7.39 ± 0.38
MI-6011, 6012	10/13/2003	K-40	1165.20 ± 118.70	1191.20 ± 99.50	1178.20 ± 77.44
MI-6034, 6035	10/14/2003	Sr-90	0.86 ± 0.33	0.90 ± 0.34	0.88 ± 0.24
VE-6055, 6056	10/15/2003	Gr. Beta	5.18 ± 0.18	5.33 ± 0.18	5.25 ± 0.13
VE-6055, 6056	10/15/2003	K-40	5.31 ± 0.57	4.52 ± 0.51	4.92 ± 0.38
MI-6291, 6292	10/21/2003	K-40	1935.60 ± 147.70	1936.10 ± 116.50	1935.85 ± 94.06
MI-6291, 6292	10/21/2003	Sr-90	1.22 ± 0.39	1.41 ± 0.37	1.31 ± 0.27
SS-6435, 6436	10/21/2003	Cs-137	0.05 ± 0.02	0.05 ± 0.03	0.05 ± 0.02
SS-6435, 6436	10/21/2003	K-40	14.08 ± 0.54	14.28 ± 0.80	14.18 ± 0.48
CF-6313, 6314	10/22/2003	K-40	14.56 ± 0.45	14.70 ± 0.95	14.63 ± 0.53
SO-6528, 6529	10/22/2003	Cs-137	0.15 ± 0.03	0.16 ± 0.05	0.16 ± 0.03
SO-6528, 6529	10/22/2003	K-40	17.46 ± 0.69	17.90 ± 1.05	17.68 ± 0.63
SO-6393, 6394	10/25/2003	Cs-137	0.09 ± 0.03	0.10 ± 0.04	0.10 ± 0.03
SO-6393, 6394	10/25/2003	Gr. Beta	23.21 ± 1.98	21.76 ± 1.91	22.48 ± 1.38
SO-6393, 6394	10/25/2003	K-40	13.98 ± 0.80	14.57 ± 0.86	14.27 ± 0.59
SWT-6507, 6508	10/28/2003	Gr. Beta	2.64 ± 0.52	2.63 ± 0.53	2.63 ± 0.37
DW-6647, 6648	10/31/2003	I-131	0.46 ± 0.27	0.61 ± 0.31	0.53 ± 0.21
BS-6603, 6604	11/3/2003	Cs-137	9.03 ± 0.82	8.60 ± 1.13	8.82 ± 0.70
BS-6603, 6604	11/3/2003	Gr. Beta	26.83 ± 1.94	27.18 ± 1.95	27.01 ± 1.38
SO-6670, 6671	11/5/2003	Cs-137	0.15 ± 0.04	0.13 ± 0.04	0.14 ± 0.03
SO-6670, 6671	11/5/2003	K-40	12.96 ± 0.66	12.95 ± 0.72	12.96 ± 0.49
S-7067, 7068	11/10/2003	Cs-137	0.21 ± 0.05	0.19 ± 0.08	0.20 ± 0.05
MI-6818, 6819	11/11/2003	K-40	1695.50 ± 129.80	1709.40 ± 143.00	1702.45 ± 96.56

TABLE A-5. In-House "Duplicate" Samples

Lab Code	Date	Analysis	Concentration (pCi/L)[a] First Result	Second Result	Averaged Result
MI-6818, 6819	11/11/2003	Sr-90	2.01 ± 0.41	1.59 ± 0.39	1.80 ± 0.28
WL-6987, 6988	11/17/2003	Fe-55	603.49 ± 53.32	619.65 ± 53.97	611.57 ± 37.93
SO-7156, 7157	11/21/2003	Cs-137	0.74 ± 0.08	0.77 ± 0.07	0.76 ± 0.06
SO-7156, 7157	11/21/2003	Gr. Alpha	14.90 ± 4.24	19.25 ± 4.45	17.07 ± 3.07
SO-7156, 7157	11/21/2003	Gr. Beta	22.97 ± 3.12	25.51 ± 2.98	24.24 ± 2.16
SO-7156, 7157	11/21/2003	K-40	12.51 ± 1.06	12.94 ± 1.07	12.73 ± 0.75
S-7281, 7282	11/24/2003	Cs-137	0.82 ± 0.15	1.16 ± 0.20	0.99 ± 0.12
SWU-7198, 7199	11/25/2003	Gr. Beta	2.60 ± 0.53	2.54 ± 0.55	2.57 ± 0.38
DW-7221, 7222	11/25/2003	Gr. Beta	12.32 ± 1.40	12.38 ± 1.43	12.35 ± 1.00
SW-7133, 7134	12/1/2003	Gr. Beta	2.10 ± 0.23	2.46 ± 0.23	2.28 ± 0.16
SW-7133, 7134	12/1/2003	K-40	1.50 ± 0.15	1.40 ± 0.14	1.45 ± 0.10
W-7519, 7520	12/1/2003	Fe-55	3.03 ± 0.65	3.12 ± 0.64	3.08 ± 0.46
SW-7805, 7806	12/1/2003	Sr-90	0.59 ± 0.32	0.56 ± 0.33	0.58 ± 0.23
VE-7399, 7400	12/9/2003	Gr. Beta	4.99 ± 0.15	5.24 ± 0.15	5.11 ± 0.11
VE-7399, 7400	12/9/2003	K-40	5.04 ± 0.46	5.34 ± 0.74	5.19 ± 0.43
SW-7540, 7541	12/9/2003	Gr. Alpha	2.64 ± 1.36	2.10 ± 1.19	2.37 ± 0.91
SW-7540, 7541	12/9/2003	Gr. Beta	6.62 ± 1.22	5.89 ± 1.35	6.25 ± 0.91
LW-7736, 7737	12/26/2003	Gr. Beta	2.62 ± 0.54	2.83 ± 0.56	2.73 ± 0.39
AP-7868, 7869	12/30/2003	Be-7	0.05 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
AP-7952, 7953	12/30/2003	Be-7	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
AP-7994, 7995	12/31/2003	Be-7	0.05 ± 0.02	0.05 ± 0.01	0.05 ± 0.01

Note: Duplicate analyses are performed on every twentieth sample received in-house. Results are not listed for those analyses with activities that measure below the LLD.

[a] Results are reported in units of pCi/L, except for air filters (pCi/Filter), food products, vegetation, soil, sediment (pCi/g).

[b] 200 minute count time or longer, resulting in lower error.

TABLE A-6. Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP)[a].

			Concentration[b]			
Lab Code	Type	Date	Analysis	Laboratory result	Known Activity	Control Limits[c]
STW-972	water	12/01/02	Am-241	0.56 ± 0.06	0.58 ± 0.09	0.40 - 0.75
STW-972	water	12/01/02	Co-57	57.10 ± 1.90	57.00 ± 5.70	39.90 - 74.10
STW-972	water	12/01/02	Co-60	38.30 ± 0.60	38.20 ± 3.82	26.74 - 49.66
STW-972	water	12/01/02	Cs-134	395.30 ± 10.10	421.00 ± 42.10	294.70 - 547.30
STW-972	water	12/01/02	Cs-137	316.40 ± 5.30	329.00 ± 32.90	230.30 - 427.70
STW-972	water	12/01/02	Fe-55	94.90 ± 24.50	96.00 ± 9.60	67.20 - 124.80
STW-972	water	12/01/02	Mn-54	33.40 ± 0.10	32.90 ± 3.29	23.03 - 42.77
STW-972	water	12/01/02	Ni-63	123.80 ± 5.50	136.50 ± 13.70	95.55 - 177.45
STW-972	water	12/01/02	Pu-238	0.66 ± 0.06	0.83 ± 0.08	0.58 - 1.08
STW-972	water	12/01/02	Pu-239/40	0.001 ± 0.001	0.000 ± 0.000	0.000 - 0.005
STW-972	water	12/01/02	Sr-90	13.80 ± 1.00	12.31 ± 1.23	8.62 - 16.00
STW-972	water	12/01/02	Tc-99	128.10 ± 3.80	132.00 ± 13.20	92.40 - 171.60
STW-972	water	12/01/02	U-233/4	1.60 ± 0.09	1.54 ± 0.15	1.08 - 2.00
STW-972	water	12/01/02	U-238	1.64 ± 0.09	1.60 ± 0.16	1.12 - 2.08
STW-972	water	12/01/02	Zn-65	540.40 ± 9.90	516.00 ± 51.60	361.20 - 670.80
STSO-987	soil	01/01/03	Co-57	534.36 ± 2.61	530.00 ± 53.00	371.00 - 689.00
STSO-987	soil	01/01/03	Co-60	442.16 ± 2.31	420.00 ± 42.00	294.00 - 546.00
STSO-987	soil	01/01/03	Cs-134	211.00 ± 2.30	238.00 ± 23.80	166.60 - 309.40
STSO-987	soil	01/01/03	Cs-137	849.50 ± 3.30	832.00 ± 83.20	582.40 - 1081.60
STSO-987	soil	01/01/03	K-40	716.50 ± 12.80	652.00 ± 65.20	456.40 - 847.60
STSO-987	soil	01/01/03	Mn-54	148.76 ± 2.84	137.00 ± 13.70	95.90 - 178.10
STSO-987	soil	01/01/03	Ni-63	597.10 ± 23.50	770.00 ± 77.00	539.00 - 1001.00
STSO-987	soil	01/01/03	Pu-238	67.05 ± 3.10	66.90 ± 6.70	46.83 - 86.97
STSO-987	soil	01/01/03	Pu-239/40	52.80 ± 3.60	52.70 ± 5.30	36.90 - 68.50
STSO-987	soil	01/01/03	Sr-90	609.50 ± 9.80	714.00 ± 71.40	499.80 - 928.20
STSO-987	soil	01/01/03	U-233/4	99.50 ± 7.60	89.00 ± 8.90	62.30 - 115.70
STSO-987	soil	01/01/03	U-238	508.60 ± 42.20	421.00 ± 42.10	294.70 - 547.30
STSO-987	soil	01/01/03	Zn-65	492.70 ± 28.10	490.00 ± 49.00	343.00 - 637.00

[a] Results obtained by Environmental, Inc. ,Midwest Laboratory as a participant in the Department of Energy's Mixed Analyte Performance Evaluation Program, Idaho Operations office, Idaho Falls, Idaho

[b] All results are in Bq/kg or Bq/L as requested by the Department of Energy.

[c] MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP.

TABLE A-7. Environmental Measurements Laboratory Quality Assessment Program (EML)

Lab Code	Type	Date	Analysis	Concentration[a] Laboratory results	EML Result[b]	Control Limits[c]
STW-977	water	03/01/03	Gr. Alpha	304.30 ± 53.10	377.50	0.58 - 1.29
STW-977	water	03/01/03	Gr. Beta	615.80 ± 14.70	627.50	0.61 - 1.43
STW-978	water	03/01/03	Am-241	2.00 ± 0.10	2.13	0.79 - 1.41
STW-978	water	03/01/03	Co-60	221.30 ± 1.20	234.00	0.80 - 1.20
STW-978 [d]	water	03/01/03	Cs-134	23.30 ± 1.10	30.50	0.80 - 1.30
STW-978	water	03/01/03	Cs-137	61.40 ± 0.60	63.80	0.80 - 1.22
STW-978 [e]	water	03/01/03	H-3	341.90 ± 22.70	390.00	0.78 - 2.45
STW-978	water	03/01/03	Pu-238	3.70 ± 0.20	3.33	0.74 - 1.20
STW-978	water	03/01/03	Pu-239/40	4.40 ± 0.10	3.92	0.79 - 1.20
STW-978	water	03/01/03	Sr-90	4.60 ± 0.30	4.34	0.69 - 1.34
STW-978	water	03/01/03	Uranium	5.10 ± 0.60	4.29	0.75 - 1.33
STSO-979	soil	03/01/03	Ac-228	55.60 ± 2.50	57.60	0.80 - 1.38
STSO-979	soil	03/01/03	Am-241	12.42 ± 0.90	15.60	0.65 - 2.28
STSO-979	soil	03/01/03	Bi-212	57.70 ± 3.20	60.60	0.50 - 1.34
STSO-979	soil	03/01/03	Bi-214	60.40 ± 3.20	67.00	0.78 - 1.42
STSO-979	soil	03/01/03	Cs-137	1416.80 ± 70.00	1450.00	0.80 - 1.25
STSO-979	soil	03/01/03	K-40	653.80 ± 11.90	636.00	0.80 - 1.32
STSO-979	soil	03/01/03	Pb-212	51.10 ± 5.20	57.90	0.78 - 1.32
STSO-979	soil	03/01/03	Pb-214	64.70 ± 5.10	71.10	0.76 - 1.46
STSO-979	soil	03/01/03	Pu-239/40	24.40 ± 0.30	23.40	0.71 - 1.30
STSO-979	soil	03/01/03	Sr-90	54.50 ± 2.60	64.40	0.67 - 2.90
STSO-979	soil	03/01/03	Uranium	245.00 ± 1.50	249.00	0.71 - 1.32
STVE-980	Vegetation	03/01/03	Am-241	3.10 ± 0.20	3.51	0.73 - 2.02
STVE-980	Vegetation	03/01/03	Cm-244	1.40 ± 0.50	2.01	0.61 - 1.59
STVE-980	Vegetation	03/01/03	Co-60	12.60 ± 0.40	12.10	0.80 - 1.44
STVE-980	Vegetation	03/01/03	Cs-137	449.70 ± 6.20	444.00	0.80 - 1.31
STVE-980	Vegetation	03/01/03	K-40	1159.00 ± 38.60	1120.00	0.79 - 1.39
STVE-980	Vegetation	03/01/03	Pu-239/40	4.80 ± 0.40	5.17	0.69 - 1.31
STVE-980	Vegetation	03/01/03	Sr-90	659.70 ± 50.40	650.00	0.55 - 1.21
STAP-981	Air Filter	03/01/03	Am-241	0.27 ± 0.10	0.34	0.70 - 2.34
STAP-981	Air Filter	03/01/03	Co-60	30.20 ± 0.30	33.50	0.80 - 1.26
STAP-981	Air Filter	03/01/03	Cs-137	90.30 ± 1.30	99.70	0.80 - 1.32
STAP-981	Air Filter	03/01/03	Mn-54	41.80 ± 0.60	43.80	0.80 - 1.35
STAP-981	Air Filter	03/01/03	Pu-238	0.52 ± 0.10	0.52	0.67 - 1.33
STAP-981	Air Filter	03/01/03	Pu-239/40	0.35 ± 0.10	0.33	0.73 - 1.26
STAP-981	Air Filter	03/01/03	Sr-90	2.50 ± 0.10	2.80	0.53 - 1.84
STAP-981	Air Filter	03/01/03	Uranium	0.51 ± 0.10	0.50	0.79 - 2.10
STAP-982	Air Filter	03/01/03	Gr. Alpha	0.90 ± 0.10	1.17	0.73 - 1.43
STAP-982	Air Filter	03/01/03	Gr. Beta	1.50 ± 0.10	1.50	0.76 - 1.36

TABLE A-7. Environmental Measurements Laboratory Quality Assessment Program (EML)

Lab Code	Type	Date	Analysis	Concentration[a] Laboratory results	EML Result[b]	Control Limits[c]
STW-992	water	09/02/03	Am-241	9.78 ± 0.32	8.76	0.79 - 1.41
The September, 2003 results are preliminary. Control limits used were taken from the March, 2003 data. Control limits may vary slightly when the final study is published.						
STW-992	water	09/02/03	Co-60	468.30 ± 4.10	513.00	0.80 - 1.20
STW-992	water	09/02/03	Cs-134	53.90 ± 0.80	63.00	0.80 - 1.30
STW-992	water	09/02/03	Cs-137	76.10 ± 1.40	80.30	0.80 - 1.22
STW-992	water	09/02/03	H-3	355.20 ± 12.80	446.30	0.78 - 2.45
STW-992	water	09/02/03	Pu-238	1.71 ± 0.07	2.07	0.74 - 1.20
STW-992	water	09/02/03	Pu-239/40	4.24 ± 0.01	4.99	0.79 - 1.20
STW-992	water	09/02/03	Sr-90	6.70 ± 0.50	7.04	0.69 - 1.34
STW-992	water	09/02/03	Uranium	6.03 ± 0.14	5.69	0.75 - 1.33
STW-993	water	09/02/03	Gr. Alpha	688.00 ± 7.60	622.00	0.58 - 1.29
STW-993	water	09/02/03	Gr. Beta	1985.00 ± 111.00	1948.00	0.61 - 1.43
STSO-994	soil	09/02/03	Am-241	19.70 ± 1.50	18.40	0.65 - 2.28
STSO-994	soil	09/02/03	Cs-137	1928.00 ± 19.00	1973.00	0.80 - 1.25
STSO-994	soil	09/02/03	K-40	533.00 ± 79.00	488.00	0.80 - 1.32
STSO-994	soil	09/02/03	Pu-238	15.30 ± 0.80	14.60	0.59 - 2.88
STSO-994	soil	09/02/03	Pu-239/40	32.50 ± 2.30	30.40	0.71 - 1.30
STSO-994	soil	09/02/03	Sr-90	69.80 ± 2.30	80.30	0.67 - 2.90
STSO-994	soil	09/02/03	Uranium	228.30 ± 17.10	259.30	0.71 - 1.32
STAP-995	Air Filter	09/02/03	Am-241	0.64 ± 0.05	0.44	0.70 - 2.34
STAP-995	Air Filter	09/02/03	Co-60	48.50 ± 0.40	55.10	0.80 - 1.26
STAP-995	Air Filter	09/02/03	Cs-137	51.20 ± 1.10	54.80	0.80 - 1.32
STAP-995	Air Filter	09/02/03	Mn-54	53.70 ± 1.10	58.00	0.80 - 1.35
STAP-995	Air Filter	09/02/03	Pu-238	0.24 ± 0.05	0.23	0.67 - 1.33
STAP-995	Air Filter	09/02/03	Pu-239/40	0.41 ± 0.10	0.40	0.73 - 1.26
STAP-995	Air Filter	09/02/03	Sr-90	1.90 ± 0.10	2.06	0.53 - 1.84
STAP-995	Air Filter	09/02/03	Uranium	0.80 ± 0.06	0.82	0.79 - 2.10
STAP-996	Air Filter	09/02/03	Gr. Alpha	3.23 ± 0.07	3.11	0.73 - 1.43
STAP-996	Air Filter	09/02/03	Gr. Beta	4.18 ± 0.03	3.89	0.76 - 1.36

[a] Results are reported in Bq/L with the following exceptions: Air Filters (Bq/Filter), Soil and Vegetation (Bq/kg).

[b] The EML result listed is the mean of replicate determinations for each nuclide ± the standard error of the mean.

[c] Control limits are reported by EML as the ratio of Reported Value / EML value.

[d] A low bias for Cs-134 activity has been observed in the past. No errors have been found in the library or efficiency. Additional spike analyses will be performed and a correction factored into the calculation.

[e] Reporting error.

APPENDIX B

DATA REPORTING CONVENTIONS

Data Reporting Conventions

1.0. All activities, except gross alpha and gross beta, are decay corrected to collection time or the end of the collection period.

2.0. Single Measurements

Each single measurement is reported as follows: $x \pm s$

where: x = value of the measurement;

s = 2s counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is less than the lower limit of detection L, it is reported as: <L, where L = the lower limit of detection based on 4.66s uncertainty for a background sample.

3.0. Duplicate analyses

3.1 Individual results: For two analysis results; $x_1 \pm s_1$ and $x_2 \pm s_2$

Reported result: $x \pm s$; where $x = (1/2)(x_1 + x_2)$ and $s = (1/2)\sqrt{s_1^2 + s_2^2}$

3.2. Individual results: $<L_1$, $<L_2$ Reported result: <L; where L = lower of L_1 and L_2

3.3. Individual results: $x \pm s$, <L Reported result: $x \pm s$ if $x \geq L$; <L otherwise.

4.0. Computation of Averages and Standard Deviations

4.1 Averages and standard deviations listed in the tables are computed from all of the individual measurements over the period averaged; for example, an annual standard deviation would not be the average of quarterly standard deviations. The average $\bar{x}$ and standard deviation s of a set of n numbers $x_1, x_2 \ldots x_n$ are defined as follows:

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

4.2 Values below the highest lower limit of detection are not included in the average.

4.3 If all values in the averaging group are less than the highest LLD, the highest LLD is reported.

4.4 If all but one of the values are less than the highest LLD, the single value x and associated two sigma error is reported.

4.5 In rounding off, the following rules are followed:

4.5.1. If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.

4.5.2. If the figure following those to be retained is equal to or greater than 5, the figure is dropped and the last retained figure is raised by 1. As an example, 11.445 is rounded off to 11.45.

APPENDIX C

Sampling Program and Locations

POINT BEACH NUCLEAR PLANT

Sample Type	Locations No.	Locations Codes (and Type)[a]	Collection Type (and Frequency)[b]	Analysis (and Frequency)[b]
Airborne Filters	6	E-1-4, 8, 20	Weekly	GB, GS, on QC for each location
Airborne Iodine	6	E-1-4, 8, 20	Weekly	I-131
Ambient Radiation (TLD's)	22	E-1-9, 12, 14-18, 20, 22-32, 34-36, 38,39	Quarterly	Ambient Gamma
Lake Water	5	E-1, 5, 6, 33	Monthly	GB, BS, I-131 on MC H-3, Sr-89-90 on QC
Well Water	1	E-10	Quarterly	GB, GS, H-3, Sr-89-90, I-131
Vegetation	8	E-1-4, 6. 9, 20	3x / year as available	GB, GS
Shoreline Silt	5	E-1, 5, 6, 8, 9, 12	2x / year	GB, GS
Soil	8	E-1-4, 6, 8, 9, 20	2x / year	GB, GS
Milk	3	E-11, 19, 21	Monthly	GS, I-131, Sr-89-90
Algae	2	E-5, 12	3x / year as available	GB, GS
Fish	1	E-13	3x / year as available	GB, GS (in edible portions)
			SPECIAL COLLECTIONS AND ANALYSES	
Airborne Filters			4 per month 1 per quarter	Sr-89, Sr-90 Sr-89, Sr-90 (comp.)
Liquid			1 per month	GA, Sr-89, Sr-90
Subsoil Water			4 per quarter	GA, GB, H-3, GS
Miscellaneous Water Samples			4-5 per year	Sr-89, Sr-90

[a] Locations codes are defined in Table 2. Control Stations are indicated by (C). All other stations are indicators.

[b] Analysis type is coded as follows: GB = gross beta, GA = gross alpha, GS = gamma spectroscopy, H-3 = tritium, Sr-89 = strontium-89, Sr-90 = strontium-90, I-131 = iodine-131. Analysis frequency is coded as follows: MC = monthly composite, QC = quarterly composite.

Point Beach Nuclear Plant

TEMPORARY CHANGE REVIEW AND APPROVAL

Note: Refer to NP 1.2.3, Temporary Procedure Changes, for requirements.

I - INITIATION

Doc Number EM Current Rev 17 Unit PB0 Temp Change No. TCN 2003-0828

Document Title Environmental Manual

Existing Effective Temporary Changes NA

Description See PBF-0026c

(If necessary, continue description of changes on PBF-0026c and attach.)

☒ Initiate PBF-0026h and include with the change.

Other documents required to be effective concurrently with the temporary change: NA

Changes pre-screened according to NP 5.1.8? ☐ NO ☒ YES (Provide documentation according to NP 5.1.8)

Screening completed according to NP 5.1.8? ☒ NA ☐ YES (Attach copy)

Safety Evaluation Required? ☒ NO ☐ YES (If Yes, a revision may be processed or final reviews and approvals shall be obtained before implementing)

Determine if the change constitutes a Change Of Intent to the procedure by evaluating the following questions.
(If any answers are YES, a revision may be processed or final reviews and approvals shall be obtained before implementing)

Will the proposed change:	YES	NO
1. Require a change to, affect or invalidate a requirement, commitment, evaluation or description in the Current or ISFSI Licensing Basis (as defined in NP 5.1.8 and NP 5.1.7)?	☐	☒
2. Cause an increase in magnitude, significance or impact such that a rev. should be processed?	☒	☐
3. Delete or modify a prerequisite, initial condition, precaution, limitation or other steps that could have safety significance or affect the procedure's margin of safety?	☐	☒
4. Delete QC hold points, Independent Verification or Concurrent Check steps without the related step(s) that require the performance also being deleted?	☐	☒
5. Change Tech Spec or other regulatory acceptance criteria other than for re-baselining?	☐	☒
6. Require a change to the procedure Purpose or change the procedure classification?	☐	☒

Initiated By (print/sign) Elaine J. Kreil / Elaine J. Kreil Date 12/17/2003

II - INITIAL APPROVAL

Group Supervisor Daniel J. Shannon / Daniel J. Shannon Date 12-17-03

(Cannot be the Initiator) This change is correct and complete, can be performed as written, and does not adversely affect personnel or nuclear safety, or Plant operating conditions.

Senior Reactor Operator (print/sign) NA / Date

(Cannot be the Initiator or Group Supervisor) This change does not adversely affect Plant operating conditions. (Safety Related procedures only)

III - PROCEDURE OWNER REVIEW

☐ Permanent ☐ One-time Use ☒ Expiration Date, Event or Condition: Until next revision

Training review recommended per NP 1.2.3? ☒ NO ☐ YES (If Yes, RFT Number per NP 1.2.3 _____)

☐ Hold change until procedure completed (final review and approval still required within 14 days of initial approval)

QC review required according to NP 1.2.3/NP 8.4.1? ☒ NA ☐ YES (If yes, QC Signature) _____

☒ QR/PORC Review NOT Required (Admin/NNSR only) ☐ QR Review Required ☐ PORC Review Required (Reference NP 1.6.5)

Procedure Owner (print/sign) Daniel J. Shannon / Daniel J. Shannon Date 12-17-03

This Change and supporting requirements correctly completed and processed

IV - FINAL REVIEW AND APPROVAL

(Must be completed within 14 days of initial approval) (The Initiator, QR and Approval Authority shall be independent from each other)

QR/PORC NA / Date PORC Meeting

Indicates 50.59/72.48 applicability assessed, any necessary screenings/evaluations performed, determination made as to whether additional cross-disciplinary review required, and if required, performed.

Approval Authority (print/sign) James H. McCarthy / Date 12-17-2003

V - REVISION INFORMATION FOR PERMANENT CHANGES

Post Typing Review (print/sign) / Date

Indicates temporary change(s) incorporated exactly as approved and no other changes made to document.

Incorporated into Revision Number _____ Effective Date _____

Point Beach Nuclear Plant
DOCUMENT REVIEW AND APPROVAL CONTINUATION

Doc Number EM Revision 17 Unit PB0

Title Environmental Manual

Temporary Change Number TCN 2003-0828

Description of Changes:

Step *	Change/Reason
2.4.5d	Deleted section on performance of quarterly leak check on environmental air samplers/contacted
	NSA Engineering to see if there were any bases for performing quarterly leak checks on environmental
	air samplers and there were none. These checks were incorporated at the initial development of the
	Environmental Manual and considered to be a good practice at the time. There were no ANSI standards,
	NUREG or regulatory requirements for air sampler leak checks. After reviewing the past two years of
	quarterly leak checks performed on the environmental air samplers and their annual calibrations it was
	determined that the quarterly leak checks may be eliminated as they are providing no additional value to
	the program. In addition, the weekly gross leak checks would identify any leakage or abnormalities in a
	more timely manner. No other air samplers at PBNP, of the same type, require quarterly leak checks.
	The annual calibration of the air samplers requires that "as found" flow rate data is obtained prior to
	performing any maintenance. A complete inspection for air leakage is performed as part of the normal
	calibration as well. This change improves the Radiological Environmental Monitoring Program/answers
	CA003287
2.4.6c	Deleted E-19 milk sampling location; added replacement milk sampling location E-40/ During the
	collection of the August 2003 monthly Environmental monitoring program milk samples, the owner of
	the dairy herd at location E-19 (Lee Engelbrecht) informed us that he is selling his cows and would not
	be participating in the program beginning next month. A replacement farm was quickly found.
	Mr. Englebrecht spoke to his neighbor Rick Barta who has a dairy herd near by and would be willing to
	participate. Mr. Barta's address is 16422 Hwy. 42, Two Rivers, ~1.8 mile north of PBNP on Hwy 42.
	Note that sampling at the replacement milk site is being conducted and has been conducted since
	notification that samples from E-19 would no longer be available/answers CA032631
Table 2-	Deleted E-19; replaced with E-40/see reason listed for Step 2.4.6c
Table 2-4	Deleted E-19; replaced with E-40/see reason listed for Step 2.4.6c
Table 2-5	Deleted E-19; replaced with E-40/see reason listed for Step 2.4.6c
Figure 2-1a	Deleted E-19; replaced with E-40/see reason listed for Step 2.4.6c

Other Comments

* Note: Recording of Step Number(s) is not required for multiple occurrences of identical information or when not beneficial to reviewers.

Point Beach Nuclear Plant

TEMPORARY CHANGE AFFECTED MANUAL LOCATION

Procedure Number EM Revision 17 Unit PB0

Title Environmental Manual

Temporary Change Number TCN 2003-0828

I - IMMEDIATELY AFTER INITIAL APPROVAL ON PBF-0026e (Non-Intent changes)
(after Final Approval if change of intent involved)

This procedure change has been processed as follows: (Manual/Location)		Date Performed
☐	Copy included in work package for field implementation. (WO No. _____)	
☐	Sign offs for completed work and QC stamps included/transferred in work package or procedure for field implementation. (WO No. _____)	
☐	Copy filed in Control Room temp change binder (Operations only).	
☒	Original change package provided to Elaine Kreil to obtain Procedure Owner Review (e.g., Owner review may be coordinated by In-Group OA II, Procedure Writer, Procedure Supervisor, etc.).	12-17-03
☐		
☐		
☐		
☐		
☐		

Performed By (print and sign) Elaine J. Kreil Elaine J. Kreil Date 12-17-03

II - PROCEDURE OWNER REVIEW ON PBF-0026e
(may be performed by OA II, Procedure Writer, etc.)

This procedure change has been processed as follows: (Manual/Location)		Date Performed
☐	Copy of permanent changes to Operations procedures forwarded to Emergency Planning and Simulator Training within the next normal working day after initial approval.	
☒	Copy sent to Document Control Distribution Lead for Master File. (Not required for one-time use change)	12-19-03
☒	Copy filed in Group satellite file. (Not required for one-time use changes.)	12-19-03
☐	Copy filed in Group one-time use file.	
☒	Original Temp Change provided to Elaine Kreil to obtain Final Approvals (e.g., final approval may be coordinated by In-Group OA II, Procedure Writer, Procedure Supervisor, etc.)	12-19-03
☒	27/RP Station	12-19-03
☒	10/Training Library	12-19-03
☒	29/S.L. Scott	12-19-03

Performed By (print and sign) Elaine J. Kreil Elaine J. Kreil Date 12-19-03

Point Beach Nuclear Plant

10 CFR 50.59/72.48 APPLICABILITY FORM

Brief Activity Title or Description: **Temporary Revision to Become Permanent to Revision 17 of Environmental Manual**

This form is required to be completed and attached to the applicable activity change forms to document all or portions of an activity that are covered by another regulation other than 10 CFR 50.59 and 10 CFR 72.48 (pre-screening criteria 2). See NP 5.1.8, 10 CFR 50.59/72.48 Applicability, Screening and Evaluation (New Rule).

NOTE: Guidance for searching the FSAR, Technical Specifications, Regulatory Commitments (CLB Commitment Database) and other licensing basis documents can be found in NP 5.1.8, Attachment G.

NOTE: Although 10 CFR 50.59 and 72.48 may not be applicable to the processes listed below, change activities conducted under these processes may require changes to the FSAR. If so, initiate FSAR changes per NP 5.2.6, FSAR Revisions.

	Regulatory or Plant Process	YES	NO
1.	Does the activity require a change to the Facility Operating License, License Conditions or Technical Specifications? (If the answer is YES, process the applicable changes per NP 5.2.7, License Amendment Request Preparation, Review and Approval.)	☐	☒
2.	**NOTE: The Quality Assurance Plan is described in FSAR Section 1.4.** Does the activity require a change to the Quality Assurance Program? If the answer is YES, process the applicable changes per NP 11.1.3, QA Program Revisions.	☐	☒
3.	**NOTE: Implementation of Security Plan changes that require physical changes to the plant, or changes to operator access to the plant require a screening.** **NOTE: Security is described in FSAR Section 12.7.** Does the activity require a change to the PBNP Security Plan, a safeguards contingency plan, or security training and qualification plan? If the answer is YES, assess the acceptability of the change per 10 CFR 50.54(p) using Security procedures.	☐	☒
4.	**NOTE: The Emergency Plan is described in FSAR Section 12.6.** Does the activity require a change to the Emergency Plan? If the answer is YES, assess the acceptability of the change per 10 CFR 50.54(q) using NP 1.8.3, 10 CFR 50.54(q) Evaluations.	☐	☒
5.	**NOTE: The Radiation Protection Program is described in FSAR Section 11.4.** Does the activity involve a change to the PBNP Radiation Protection Program or its implementing procedures, AND the activity in its entirety is within the requirements of 10 CFR 20, Standards for Protection Against Radiation?	☐	☒
6.	**NOTE: Changes to the plant or method of evaluation that result in re-analysis of the FSAR loss-of-coolant accident (LOCA) analysis require a screening.** Does the activity require a change to the FSAR LOCA analysis results subject to 10 CFR 50.46, Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors? If the answer is YES, process the applicable changes per NP 5.2.12, 10 CFR 50.46 Reporting Requirements, and NP 5.2.6, FSAR Revisions.	☐	☒
7.	**NOTE: Regulatory commitments are found in the CLB Commitment Database.** Does the activity involve a change to a Regulatory Commitment ? If the answer is YES, process the applicable changes per NP 5.1.7, Regulatory Commitment Changes.	☐	☒

Point Beach Nuclear Plant

10 CFR 50.59/72.48 APPLICABILITY FORM

	Regulatory or Plant Process	YES	NO
8.	Does the activity involve a change to the Environmental Manual (EM), Radiological Effluent Control Program Manual (RECM), Offsite Dose Calculation Manual (ODCM), or Process Control Program (PCP), AND does NOT involve changes in use of explosive gases in waste treatment systems? If the answer is YES, document the applicable changes per the requirements of TS 5.5.1.	☒	☐
	NOTE: For purposes of determining 10 CFR 50.59 / 72.48 applicability, the determination of an administrative procedure below takes precedence over definitions or classifications in other plant procedures or guidelines.		
9.	Does the activity involve initial issue or a change to an administrative procedure or controlled document, OR an administrative software change ONLY?	☒	☐
	ALL of the following statements have to be marked YES for the procedure, controlled document, or software change to be considered administrative.		
	a. DOES NOT direct, control or provide data as to how plant structures, systems, or components are operated, maintained, tested or repaired either specifically OR generically.	☒	☐
	b. DOES NOT specify acceptance criteria or operating limits for plant structures, systems, or components or demonstrates criteria/limits are met.	☒	☐
	c. DOES NOT specify parts, materials, chemicals, lubricants, etc. to be used in plant structures, systems, or components.	☒	☐
	d. DOES NOT specify compensatory action(s) to address plant structures, systems, or components out of service, or to address non-conforming conditions.	☒	☐
	e. DOES NOT affect operator access to operating areas of the plant.	☒	☐

10 CFR 50.59/72.48 APPLICABILITY CONCLUSION

NOTE: If ANY portion of the activity is NOT controlled by one or more of the processes above, further 10 CFR 50.59 / 72.48 review is required (i.e., portions not covered by the above processes shall be prescreened to other criteria or screened).

ALL aspects of the activity are controlled by one or more of the processes above, therefore NO additional 10 CFR 50.59 and 72.48 review is required.	YES	NO
	☒	☐

If the above question is answered NO, briefly describe the portions of the activity NOT covered by one or more of the above processes:

Performed By	Elaine J. Kreil (Name (Print))	Elaine J. Kreil (Signature)	Date 12/17/2003
Reviewed By	Daniel J. Shannon (Name (Print))	Daniel J. Shannon (Signature)	Date 12-17-03

EM

ENVIRONMENTAL MANUAL

DOCUMENT TYPE:	Controlled Reference
REVISION:	17
EFFECTIVE DATE:	August 16, 2002
APPROVAL AUTHORITY:	Plant Manager
PROCEDURE OWNER (title):	Group Head
OWNER GROUP:	Nuclear Safety Analysis

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1.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ADMINISTRATION

1.1 Definition and Basis

1.1.1 Definition

Radiological environmental monitoring is the measurement of radioactivity in samples collected from the atmospheric, aquatic and terrestrial environment around the Point Beach Nuclear Plant (PBNP). Monitoring radioactivity in effluent streams at or prior to the point of discharge to the environment is not part of the Radiological Environmental Monitoring Program (REMP).

1.1.2 Basis

The REMP is part of the PBNP Radiological Effluent and Materials Control and Accountability Program (REMCAP). The REMP is designed to fulfill the requirements of 10 CFR 20.1302, PBNP GDC 17, GDC 64 of Appendix A to 10 CFR 50, and Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50.

No significant radionuclide concentrations of plant origin are expected in the plant environs because radioactivity in plant effluent is continuously monitored to ensure that releases are well below levels which are considered safe upper limits. The REMP is conducted to demonstrate compliance with applicable standards, to assess the radiological environmental impact of PBNP operations, and to monitor the efficacy of inplant effluent controls. The REMP, as outlined in Tables 2-2 through 2-4 is designed to provide sufficient sample types and locations to detect and to evaluate changes in environmental radioactivity.

Radioactivity is released in liquid and gaseous effluents. Air samplers and thermoluminescent dosimeters placed at various locations provide means of detecting changes in environmental radioactivity as a result of plant releases to the atmosphere. Because the land area around PBNP is used primarily for farming and dairy operations, sampling of vegetation is conducted to detect changes in radiological conditions at the base of the food chain. Sampling of area-produced milk is conducted because dairy farming is a major industry in the area.

Water, periphyton, and fish are analyzed to monitor radionuclide levels in Lake Michigan in the vicinity of PBNP. Periphyton, attached algae, along with lake water samples, provide a means of detecting changes which may have a potential impact on the radionuclide concentrations in Lake Michigan fish. Because of the migratory behavior of fish, fish sampling is of minimal value for determining radiological impact specifically related to the operation of the Point Beach Nuclear Plant. However, fish sampling is carried out as a conservative measure with emphasis on species which are of intermediate trophic level and which exhibit minimal migration in order to monitor the status of radioactivity in fish.

Vegetation, algae, and fish sampling frequencies are qualified on an "as available" basis recognizing that certain biological samples may occasionally be unavailable due to environmental conditions.

1.2 Responsibilities for Program Implementation

1.2.1 Nuclear Safety Analysis (NSA) Functions

NSA together with Regulatory Services/Licensing (RSL) provides the Plant Manager with the technical, regulatory, licensing, and administrative support necessary for the implementation of the program. The NSA administrative functions relating to the REMP fall into the six broad areas outlined below.

a. Program scope

The scope of the REMP is determined by the cognizant NSA Radiological Engineer based on sound radiological principles for the fulfillment of PBNP Technical Specifications (TS) and the applicable Federal Regulations. Based on the scope, the Environmental Manual (EM) is written to accomplish the collection and analyses of the necessary environmental samples. The EM is revised as necessary to conform to changes in procedures and scope. Nuclear Safety Analysis (NSA) monitors the REMP effectiveness and compliance with TS and with the procedures and directives in the EM. In order to verify compliance with TS, NSA or site quality assurance arranges for program audits and audits of the contracted radioanalytical laboratory.

b. Record keeping

The monthly radioanalytical results from the contracted laboratory are reviewed by NSA and one copy of the monthly radioanalytical results from the contracted laboratory is kept for the lifetime of the plant.

c. Data monitoring

NSA reviews and interprets all program analytical results on a monthly basis as they are reported. Trends, if any, are noted. Any resulting corrections, modifications and additions to the data are made by NSA. Inconsistencies are investigated by NSA with the cooperation of Radiation Protection (RP) and contractor personnel, as required. Unusual results as evidenced by radioactivity levels exceeding administrative notification levels are also investigated. Results of the investigation will be conveyed to the Plant Manager. The NSA will promptly inform the Plant Manager of any sample exceeding Nuclear Regulatory Commission (NRC) regulatory notification levels and will initiate an investigation. A formal report shall be provided to the Plant Manager upon completion of the investigation.

d. Data summary

Results from the Radiological Environmental Monitoring Program shall be summarized annually for inclusion in the PBNP Annual Monitoring Report. This summary advises the Plant Manager of the radiological status of the environment in the vicinity of PBNP. The summary shall include the numbers and types of samples as well as the averages, statistical confidence limits and the ranges of analytical results. Methods used in summarizing data are at the discretion of NSA.

e. Contractor communications

Communication with the contractor regarding data, analytical procedures, lower limits of detection, notification levels and contractual matters are normally conducted by the NSA. Communication regarding sample shipment may be done by either RP or NSA as appropriate.

f. Reportable items

1. NSA shall generate all technically-specified reports related to the operation of the Radiological Environmental Monitoring Program. The material included shall be sufficient to fulfill the objectives outlined in Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50. The following items and occurrences, are required to be reported in the PBNP Annual Monitoring Report:

   (a) Summary and discussion of monitoring results including number and type of samples and measurements, and all detected radionuclides, except for naturally occurring radionuclides;

   (b) Unavailable, missing, and lost samples and plans to prevent recurrence and comments on any significant portion of the REMP not conducted as indicated in Tables 2-3 through 2-4.

   (c) New or relocated sampling locations and reason for change;

   (d) LLDs that are higher than specified in Table 2-2 and factors contributing to inability to achieve specified LLDs;

   (e) Notification that the analytical laboratory does not participate in an interlaboratory comparison program and corrective action taken to preclude a recurrence; and

   (f) Results of the annual milk sampling program land use census "milk survey" to visually verify that the location of grazing animals in the vicinity of the PBNP site boundary so as to ensure that the milk sampling program remains as conservative as practicable.

2. The following items are required to be reported to the NRC within 30 days of occurrence pursuant to the criteria of Section 2.2.4:

   (a) Confirmed environmental radionuclide concentrations, attributable to PBNP effluents, in excess of notification levels;

   (b) Confirmed results of weighted sum calculations involving radionuclide concentrations, attributable to PBNP effluents, in environmental samples in excess of the specified notification level; and

(c) The report shall, to the extent possible, identify the cause(s) for exceeding the limit(s) and define the corrective actions taken to reduce radioactivity in effluents so that the potential dose to a member of the public will not exceed the annual limits.

3. The annual results from the contracted REMP analytical laboratory as well as the laboratories analytical QA/QC results, in-house blanks, interlaboratory comparisons, etc., shall be transmitted to the NRC, Region III, with, or as a separate concurrent submittal, the Annual Monitoring Report.

4. The Annual Monitoring Report for the previous 12 month period, or fraction thereof, ending December 31, shall be submitted to the NRC by April 30 of the following year.

1.2.2 Non-NSA Functions

The primary responsibility for the implementation of the Point Beach Nuclear Plant (PBNP) Radiological Environmental Monitoring Program and for any actions to be taken at PBNP, based on the results of the program, resides with the Plant Manager.

a. Manual control and distribution

The distribution of the PBNP Environmental Manual is the responsibility of RSL.

b. Program coordination

The daily operation of the program is conducted by PBNP Radiation Protection personnel, and other qualified personnel as required, under the supervision of a Radiation Protection Management Employee who consults, as needed, with NSA. The daily administrative functions of the Radiation Protection Management Employee address those functions required for the effective operation of the PBNP Radiological Environmental Monitoring Program. These administrative functions include the following:

1. Ensuring that samples are obtained in accordance with the type and frequency in Table 2-4 following procedures outlined in this manual;

2. Ensuring adequate sampling supplies and calibrated, operable equipment are available at all times;

3. Ensuring that air sampling pumps are maintained, repaired and calibrated as required and that an adequate number of backup pumps are readily available at all times;

4. Reporting lost or unavailable samples as well as other potential deviations from the sampling regime in Table 2-4 via the Corrective Action Program and notifying the cognizant NSA RE.

5. Assisting the State of Wisconsin in obtaining samples at co-located and other sampling sites based upon a yearly, renewable agreement; and

6. Assisting NSA, as necessary with investigations into elevated radioactivity levels in environmental samples.

1.3 Quality Assurance/Quality Control

Quality assurance considerations are an integral part of PBNP's Radiological Environmental Monitoring Program. The program involves the interaction of NSA, site quality assurance and the contracted analytical vendor. The contracted vendor shall be participating in an interlaboratory comparison program. The laboratory is audited periodically, either by PBNP or by an independent third party.

Quality control for the PBNP portion of the Radiological Environmental Monitoring Program is achieved by following the procedures contained in this manual. Health Physics Technologists (HPTs) collect, package and ship environmental samples under the supervision of Radiation Protection supervisors. They are advised by Radiation Protection Management who has immediate responsibility for the overall technical operation of the environmental sampling functions. The HPTs receive classroom training as well as on-the-job training in carrying out these procedures.

An audit of the PBNP Radiological Environmental Monitoring Program and its results shall be completed periodically as a means of monitoring program effectiveness and assuring compliance with program directives. The audit shall be performed by either NSA personnel, site quality assurance, or a qualified consulting firm and in accordance with ODCM section 1.4.

1.4 Program Revisions

This manual describes the current scope of the PBNP Radiological Environmental Monitoring Program. Program items or procedures periodically may be updated or changed, consistent with good radiologically monitoring practices, either to reflect new conditions or to improve program effectiveness. Technical and program features described in this manual may be changed with the approval of the Plant Manager pursuant to the ODCM.

2.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

2.1 Program Overview

2.1.1 Purpose

No significant or unexpected radionuclide concentrations of plant origin are expected because each normal effluent pathway at PBNP is monitored at or before the release point. However, the Radiological Environmental Monitoring Program is conducted to verify that plant operations produce no significant radiological impact on the environment and to demonstrate compliance with applicable standards.

2.1.2 Samples

Samples for the Radiological Environmental Monitoring Program are obtained from the aquatic, terrestrial and atmospheric environment. The sample types represent key indicators or critical pathways identified by applying sound radiological principles to the PBNP environment.

2.1.3 Monitoring sensitivity

The effectiveness of the Radiological Environmental Monitoring Program in fulfilling its purpose depends upon the ability to accurately determine the nature and origins of fluctuations in low levels of environmental radioactivity. This requires a high degree of sensitivity so that it is possible to correctly discriminate between fluctuations in background radiation levels and levels of radioactivity that may be attributable to the operation of PBNP. Therefore, personnel actively participating in the monitoring program should make every effort to minimize the possibility of contaminating environmental samples and to obtain samples of the appropriate size.

2.2 Program Parameters

2.2.1 Contamination avoidance

Contamination prevents the accurate quantification of environmental radioactivity and the correct differentiation between fluctuating background radioactivity and levels of radioactivity attributable to the operation of PBNP. Therefore, it is necessary that all personnel associated with collecting and handling radiological environmental samples take the appropriate precautions to minimize the possibility of contaminating the samples. Some of the precautions that should be taken and which will help to minimize contamination are listed below:

a. Equipment which has been on the controlled side, even if released clean, should not normally be used in conjunction with radiological environmental monitoring. An exception to this is the HPTI equipment used to calibrate the air flow calibrator.

b. Store sampling equipment in radiologically clean areas only;

c. Store radiological environmental samples only in radiologically clean areas when samples cannot be shipped to the contractor on the same day they are collected;

d. Treat each sample as a possible source of contamination for other samples so as to minimize the possibility of cross-contamination;

e. Radiological environmental monitoring equipment should be repaired in clean-side shops;

f. Contamination avoidance for environmental TLDs is covered in Section 2.4.2; and

g. Avoid entering contaminated areas prior to collecting environmental samples.

2.2.2 Sample size

Sample size affects the sensitivity achievable in quantifying low levels of environmental radioactivity. Therefore, sampling personnel must attempt to attain the quantities of sample specified in Table 2-1. When a range is given, every effort should be made to obtain a quantity at the upper part of the range.

2.2.3 Lower limit of detection

The sensitivity required for a specific analysis of an environmental sample is defined in terms of the lower limit of detection (LLD). The LLD is the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with a 95% probability and have only a 5% probability of falsely concluding that a blank observation represents a real signal. Mathematically, the LLD is defined by the formula

$$LLD = \frac{4.66\, S_b}{E \times V \times 2.22 \times Y \times EXP(-\lambda \Delta T)}$$

Where

LLD	=	the a priori lower limit of detection in picocuries per unit volume or mass, as applicable;
S_b	=	the standard deviation of the background counting rate or the counting rate of a blank sample, as appropriate, in counts per minutes;
E	=	counting efficiency in counts per disintegration;
V	=	sample size in units of volume or mass, as applicable;
2.22	=	number of disintegrations per minute per picocurie;
Y	=	the fractional chemical yield as applicable;
λ	=	the radioactive decay constant for the particular radionuclide; and
ΔT	=	the elapsed time between sample collection, or the end of the collection period, and the time of counting.

Typical values of E, V, Y, and ΔT are used to calculate the LLD. As defined, the LLD is an a priori limit representing the capability of a measuring system and not an a posteriori limit for a particular measurement.

The required analysis for each environmental sample and the highest acceptable LLD associated with each analysis are listed in Table 2-2. Whenever LLD values lower than those specified in Table 2-2 are reasonably achievable, the analytical contractor for the radiological environmental samples will do so. When the LLDs listed in Table 2-2 are not achieved, a description of the factors contributing to the higher LLD shall be reported in the next PBNP Annual Monitoring Report.

2.2.4 Notification levels

The Notification Level (NL) is that measured quantity of radioactivity in an environmental sample which, when exceeded, requires a notification of such an occurrence be made to the appropriate party. Regulatory and administrative notification levels are listed in Table 2-2.

a. Regulatory notification levels

The regulatory notification levels listed in Table 2-2 represent the concentration levels at which NRC notification is required. If a measured level of radioactivity in any radiological environmental monitoring program sample exceeds the regulatory notification level listed in Table 2-2, resampling and/or reanalysis for confirmation shall be completed within 30 days of the determination of the anomalous result. If the confirmed measured level of radioactivity remains above the notification level, a written report shall be submitted to the NRC. If more than one of the radionuclides listed in Table 2-2 are detected in any environmental medium, a weighted sum calculation shall be performed if the measured concentration of a detected radionuclide is greater than 25% of the notification levels. For those radionuclides with LLDs in excess of 25% of the notification level, a weighted sum calculation needs to be performed only if the reported value exceeds the LLD. Radionuclide concentration levels, called Weighted Sum Action Levels, which trigger a weighted sum calculation are listed in Table 2-2.

The weighted sum is calculated as follows:

$$\frac{\text{concentration (1)}}{\text{notification level (1)}} + \frac{\text{concentration (2)}}{\text{notification level (2)}} + \ldots = \text{weighted sum}$$

If the calculated weighted sum is equal to or greater than 1, resampling and/or reanalysis for confirmation shall be completed within 30 days of the determination of the anomalous result. If the confirmed calculated weighted sum remains equal to or greater than 1, a written report shall be submitted to the NRC. This calculation requirement and report is not required if the measured level of radioactivity was not the result of plant effluents.

b. Administrative notification levels

The administrative notification levels are the concentration levels at which the contracted analytical laboratory promptly notifies NSA by phone, followed by a formal written communication. The administrative notification levels are set lower than the NRC regulatory notification levels and lower than, or equal to, the weighted sum action levels so that the nature and origin of the increased level of environmental radioactivity may be expeditiously ascertained and corrective actions taken if required.

2.2.5 Sampling locations

A list of sampling locations and the corresponding location codes appear in Table 2-3. The locations also are shown in Figures 2-1a, 2-1b, and 2-1c. It is conceivable that samples may become unavailable from specified sample locations. If this were to occur, new locations for obtaining replacement samples shall be identified and added to the Radiological Environmental Monitoring Program. If milk or vegetation samples become unavailable from the specified sampling locations, new sampling locations will be identified within 30 days. The specific locations where samples were unavailable may be deleted from the monitoring program. A formal, written reason for the new site and its location shall be transmitted to NSA who will make the appropriate changes to the Environmental Manual. Any significant changes in existing sampling location and the criteria for the change shall be reported in the Annual Monitoring Report for the period in which the change occurred. Additional sampling locations may be designated if deemed necessary by cognizant company personnel. Figures and tables in this manual shall be revised to reflect the changes.

2.2.6 Sampling media and frequency

The sampling frequency for the environmental media required by the PBNP REMP is found in Table 2-4. In addition to samples required by the former Technical Specifications, the Radiological Environmental Monitoring Program also includes the sampling of soil and shoreline sediment. To ensure that all samples are obtained at the appropriate times, a checklist is used. The checklist provides a month-by-month indication of all samples, to be obtained at each sampling location (PBF-4121a through 41211). These checklists also identify the schedule for the annual milk survey and provides space for recording the date samples were shipped offsite for analysis. In addition, the checklist lists each sampling location to identify all samples, to be obtained and the collection date. Because the weekly air samples require additional information, a separate checklist is used for each individual air sampling location for calculations and other information as shown in PBF-4078.

It is recognized that on occasions samples will be lost or that samples cannot be collected at the specified frequency because of hazardous conditions, seasonable unavailability, automatic sampling equipment malfunctions and other legitimate reasons. Reasonable efforts will be made to recover lost or missed samples if warranted and appropriate. If samples are not obtained at the indicated frequency or location, the reasons or explanations for deviations from the sampling frequency specified in Table 2-4 shall be submitted to the PBNP Corrective Action Program.

2.2.7 Sample labeling

All samples must be properly labeled to ensure that the necessary information is conveyed to the analytical contractor and that the results are associated with the correct geographical location. Each label (PBF-4026) must contain the following:

a. Sample type;

b. Sample location from Table 2-3;

c. Date and time (as appropriate) collected;

d. Air samples must show the total volume in m^3; volumes for water and milk are in gallons; vegetation, sediment, soil, and algae are indicated as ≤1000 grams; and fish ≥1000 grams;

e. Analyses for routine samples are indicated as "per contract." For special samples, the Radiation Protection manager or another Radiation Protection Management Employee will designate the analyses required; and

f. Name of person collecting the sample.

A permanent or indelible ink type felt-tip marker shall be used.

A separate sample label is needed for each sample type and location. Labels are securely attached to each sample container. In addition to sample labels, other identifying markings may be placed on sample containers as appropriate.

2.2.8 Sample shipping

All environmental samples are shipped to a contractor for analysis. The samples shall be packaged and shipped in such a way as to minimize the possibility of cross-contamination, loss, spoilage and leakage. Each sample shipment shall have a typed cover letter and, when appropriate, a contractor data collection sheet. Included in the letter shall be the same information required for the sample labels as well as the specific analyses required. The original cover letter and data collection sheet shall be sent to the contractor under separate cover; one copy of each is to be used as a packing list and a copy of each shall be kept in the appropriate PBNP file.

2.2.9 Sample analyses and frequency

The PBNP REMP samples shall be analyzed for designated parameters at the frequency listed in Table 2-4. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to effluents from PBNP. Typically, this entails the scanning of the spectrum from 80 to 2048 keV and decay correcting identified radionuclides to the time of collection. The analysis specifically includes, but is not limited to, Mn-54, Fe-59, Zn-65, Co-58, Co-60, Zr-Nb-95, Ru-103, I-131, Cs-134, Cs-137, Ba-La-140, Ce-141, and Ce-144.

2.2.10 Analytical laboratory

The analyses shall be performed by a laboratory that participates in an interlaboratory crosscheck program. If the laboratory is not participating in such a program, a report shall be made pursuant to 1.2.1.f.1.(e). The current laboratory is:

Environmental Incorporated Midwest Laboratory
700 Landwehr Road
Northbrook, IL 60062-4517
(847) 564-0700

This laboratory performs the analyses in such a manner as to attain the desired LLDs. The contracted laboratory participates in an inter-laboratory comparison crosscheck program.

The contractor is responsible for providing prompt notification to the cognizant Radiological Engineer regarding any samples found to exceed the administrative notification levels as identified in Table 2-2.

2.3 Assistance to the State of Wisconsin

As a courtesy and convenience, PBNP personnel obtain certain environmental samples for the Section of Radiation Protection, Department of Health and Family Services of the State of Wisconsin as listed in Table 2-5. A checklist is used. In addition, a State of Wisconsin air sampling data sheet is submitted with each sample obtained at Wisconsin air sampling locations serviced by PBNP personnel.

State of Wisconsin precipitation samples collected twice a month (or as available) require a state sample tag to be placed in a box with the quart cubitainer. State supplied labels for air particulate filters require start and stop time, date and beginning and ending volume. Fish sent to the state identify only the quarter and the year using a PBNP label (PBF-4026). The monthly lake water sample may be picked up by state personnel and in which case these samples require only that the date and location be written on the box for the cubitainer. The well water samples, 2 times/year, may be picked similar to lake water samples.

Samples obtained for the State of Wisconsin are either given directly to state personnel or shipped as required. The department address is:

State Lab of Hygiene
Radiochemistry Unit
2601 Agriculture Dr.
PO Box 7996
Madison, Wisconsin 53707-7996

2.4 Specification of Sampling Procedures

General radiological environmental sampling procedures follow the directives presented in Sections 2.1 and 2.2. Specific information for handling individual sample types follow.

2.4.1 Vegetation

Vegetation samples consist of green, growing grasses and weeds and are obtained three times per year, as available, from specified locations. New growth, not dead vegetation, should be used because these samples are indicators of recent atmospheric deposition. Use a scissors or other sharp cutting tool to cut the grasses and weeds off as close to the ground as possible. Do not include plant roots and take care not to contaminate the sample with soil. Total sample collected should exceed 500 grams and ideally should be 1000 grams. Place entire sample in an appropriate container, such as a plastic bag (tape the bag shut) and label the container as described in Section 2.2.7.

2.4.2 Thermoluminescent dosimeters (TLDs)

TLDs capable of multiple, independent measurements of the same exposure are posted at locations specified in Table 2-4 and are changed quarterly. The utmost care in handling is required to minimize unnecessary exposure during transit, storage and posting because the TLDs begin recording all radiation from the moment they are annealed (heated to rezero) at the contractor's laboratory. Packages of TLDs in transit should be marked "DO NOT X-RAY."

Transportation control (TLDs) shall accompany the new batch in transit from the contractor's laboratory to the plant. The control TLDs shall accompany the batch during brief storage and subsequent posting. The same control TLDs shall accompany the "old" or exposed batch on its way back to the contractor. Therefore, each control represents the sum of approximately half the in-transit exposure of the two batches. This control system is able to identify any unusual in-transit exposure.

Environmental TLDs should never be brought into the plant RCA or any other area with elevated radiation, but may be stored for brief periods in a shielded enclosure in the RP Office Area or other low background area, such as the Energy Information Center or the Site Boundary Control Center. The contractor is to time shipments to coincide as closely as possible with the beginning of a calendar quarter. TLDs should be shipped back to the contractor immediately or within 24 hours of removal. The contractor is instructed to process the samples immediately upon receipt. The contractor shall report removal data and cumulative readings in mR for all locations and control, correct for in-transit exposure and express results in net mR/7 days. Labels of the exposed set for shipment to contractor should show both posting and removal dates.

2.4.3 Lake water

Lake water samples are obtained monthly at specified locations. The contractor is responsible for the compositing for quarterly analyses. Collect approximately 8000 ml of lake water in the required number of cubitainers, or other appropriate containers, at each location and label as directed in Section 2.2.7.

Also, lake water is collected for the State of Wisconsin pursuant to Table 2-5. The sample is collected, labeled, and forwarded to the appropriate State agency.

2.4.4 Well water

Well water samples are obtained quarterly from the single onsite well. Collect approximately 8000 ml of well water using the required number of cubitainers or other appropriate containers. Label as directed in Section 2.2.7.

2.4.5 Air

a. Sample collection

Air filters are changed weekly at specified locations. Take precautions to avoid loss of collected material and to avoid contamination when handling filters. Washing hands before leaving the plant to change filters is a recommended practice.

Both particulate filters and charcoal cartridges are employed at each sampling location. Particulate filters are analyzed for gross beta activity after waiting for at least 24 hours to allow for the decay of short-lived radon and thoron daughter products. The contractor makes quarterly composites of the weekly particulate samples for gamma isotopic analyses.

A regulated pump (Eberline Model RAS-1 or equivalent) is used at each air sampling location. Because of the automatic flow regulation, rotameter readings at the beginning and ending of the sampling period should be nearly identical. Substantial differences in readings usually require some investigation to determine the cause. The rotameters attached to the pumps are calibrated in liters per minute. When new filters are installed, flow rate should be about 28-30 lpm. Flow rates less than 26 lpm or greater than 32 lpm require that the pump regulator be readjusted. The correct flow rate is determined by multiplying the rotameter reading by the correction factor indicated on the calibration sticker affixed to the rotameter.

Some pumps are equipped with an elapsed time meter which reads in hours. Form PBF-4078 is used for recording pertinent air sampling data for each location. At a normal filter change, the following procedure will apply:

1. Record "date off" and "time off."

2. Record rotameter reading for end of period (R_2).

3. Turn off pump, if necessary, and record hour meter reading or actual time for end of period (t_2).

4. Before removing the filter, label the envelope as directed in Section 2.2.7. Also enter any other pertinent information at this time. Always write data on the envelope before the particulate filter is in the envelope.

5. Remove particulate filter being careful to handle filter only by edges, place in envelope.

6. Remove charcoal cartridge, place in plastic bag, and label as directed in Section 2.2.7.

7. Install new charcoal cartridge and particulate filter being sure to check the charcoal cartridge for breaks and the particulate filter for holes in the filter surface. Discard unacceptable filter media.

8. Record "date on."

9. Record hour meter reading or time for beginning of period (t_1).

10. Turn pump on (if necessary).

11. Perform weekly gross leak test by blocking the air flow with a large rubber stopper. (For this test only, the rotameter ball may register zero or drop all the way to the bottom. The difference between zero and the bottom is not significant.)

12. Record rotameter reading for beginning of period (R_1).

13. Record correction factor as indicated on calibration sticker affixed to rotameter (C).

14. Observe that the starting rotameter reading (R_1) is close to the previous ending reading (R_2). A substantial difference indicates need for further investigation because the regulator will generally maintain constant flow regardless of filter loading.

15. Calculate total volume for period and enter on data sheet (m^3). (This step may be performed at a later time.)

16. Any unusual conditions or observations should be referenced under (*) and recorded under "*NOTES" at the bottom of the data sheet.

    Air samples are collected for the State of Wisconsin at two locations, one of which is co-located with a PBNP air sampling site. They are handled in a manner similar to PBNP samples except that no charcoal cartridges are involved. However, state samplers are equipped with volume integrating meters. Therefore, clock time must be recorded in addition to the ending and beginning volumes. Label and forward samples to the State.

b. Air sampling system description

The air monitoring equipment for the PBNP air sampling program consists of a Regulated Rate Control System. The Regulated Rate Control System is used at PBNP because of its simplicity and reliability. It is designed to minimize both calibration difficulties and the potential for leaks. The regulated rate control system includes a pump, a flow regulator, the appropriate filter holders and a minimum of tubing. Also, it may include an elapsed time meter. In this system, the total volume sampled can be calculated simply and accurately from the elapsed time and the flow rate which is kept constant by the regulator regardless of filter loading.

The air samplers are Eberline Model RAS-1 (or equivalent) and have built-in rotameters which read in liters per minute. The systems also include an Eberline WPH-1 (or equivalent) weatherproof housing and an iodine cartridge holder and mounting kit and may include an electric hour meter. Glass fiber, 47 mm diameter, particulate filters capable of collecting 95% of 1 micron diameter particles and iodine impregnated charcoal cartridges (Scott or equivalent) constitute the filter media.

c. Calibration

Calibrate the pump rotameter at initial installation and at yearly intervals thereafter by connecting a laboratory-quality reference flow meter with NIST traceable calibration to the filter face with the particulate filter and charcoal cartridge in position. Upon completion, a calibration sticker indicating the correction factor is affixed to, or near, the built-in rotameter. The results are recorded on Form PBF-4020.

d. Inspection and maintenance

~~Initially, and at quarterly intervals, not to exceed 16 weeks, thereafter, the assembled system should be checked for leaks by attaching the reference flow meter across the face of the filter holder with the filters in position. Leakage in this configuration is indicated by a higher reading on the built-in rotameter than on the reference flow meter. Because leakage is indicated by disagreement between the two flow measuring devices, remember to apply the calibration correction factor to the built-in rotameter reading. Leak tests are to be recorded on Form PBF-4020.~~
Weekly gross leak checks ~~and quarterly leak tests~~ shall be accomplished as indicated in the appropriate PBNP procedure.

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For normal operation, the regulators should be adjusted to maintain a true flow rate of 28-30 liters per minute. Adjustments are made by turning the screw marked FLOW ADJUST located on the side of the regulator body: counterclockwise increases flow, clockwise decreases flow. Flow rates should be observed at all filter changes. Flow rates less than 26 lpm or more than 32 lpm require readjustment of the regulator. Particular attention should be paid to flow rate readings with the "old," loaded filter and with new, unused filters in position. Because of the regulator, the difference in flow should be barely perceptible, perhaps no more than one lpm. Significant differences in flow rates require further investigation to determine the cause.

Preventive maintenance shall be performed as indicated in the appropriate PBNP procedure on all environmental air samplers and the results recorded on Form PBF-4020.

e. Pump repair and replacement

The pumps can operate for long periods of time with minimal or no maintenance. The vane assembly of the pump is most susceptible to failure, indicated by excessive noise or inability to maintain sufficient flow across loaded filters. At least one standby pump should be available for temporary service during the repair period. In the event of motor failures due to causes other than defective connections, complete replacement of the unit may be necessary. All pump repairs should be done in a clean-side shop with clean tools.

2.4.6 Milk

Because of iodine decay and protein binding of iodine in aging milk samples, speed is imperative in processing and samples must be kept cool to avoid degradation and spoilage of the samples. Milk samples are obtained monthly in conjunction with the State of Wisconsin Milk Sampling Program from three individual dairy farmers located north, south, and west of the site. Milk sampling data can also be obtained from the Kewaunee Nuclear Power Plant, whose radiological environmental monitoring program includes samples taken from a dairy in Green Bay, WI. This location could act as a control location.

Because two of the three sites are co-located, the PBNP pickup is coordinated to coincide with the State arranged schedule. The pickup usually will be the first Wednesday of the month.

The following sequence should be followed:

a. After verifying the State milk pickup date with the Manitowoc Public Health Department (Mr. Mark Chatenka, phone number 683-4454), notify Mr. Leon Strutz (755-2060) of the pickup date. This must be done because the Strutz farm (PBNP sampling location E-21) is not a State of Wisconsin sampling site.

b. Because the milk must be kept cool, but not frozen, fill enough cubitainers, or other appropriate containers, with water and freeze to be able to put one in each shipping container. Fill the containers with water and freeze the day preceding the pickup.

c. The milk from the Strutz farm (E-21) must be picked up before 0900 because that is the time the Strutz milk is shipped. A late arrival may mean a missed sample. Milk from sites E-11 and E-~~19~~ 40 may be picked up any time after the Strutz pickup.

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d. Identify yourself and the nature of your business at each milk pickup site. Collect two one-gallon samples from each site, using a funnel if necessary. If shipment cannot occur on the collection day, store the milk in a clean-side refrigerator overnight. DO NOT FREEZE.

e. Complete a PBNP sample tag according to Section 2.2.7 for each gallon sample and place in the box with the sample. Do not seal the box. Place the samples in insulated containers and turn them over to Ready Stores personnel for shipment. Make sure that the cover letter and, as appropriate, the contractor data collection sheets are sent according to Section 2.2.8 of this manual.

2.4.7 Algae

Filamentous algae are collected from pilings or rocks three times per year, as available, from two locations. The long, grassy, dark green algae can normally be cut with scissors. The shorter, light green algae normally must be scraped from rocks or pilings. When scraping algae, be careful not to include pieces of rock in the sample. The sample can be lightly rinsed in the same medium in which it is growing. This rinse will help rid the sample of pieces of rock and gravel that may have been inadvertently collected with the sample. Because rocks and sediment contain naturally occurring radioactive materials, their inclusion may give false sample results. Collect between 100 and 1000 gm of algae. A sample greater than 500 gm is preferred. Place the algae in a wide-mouth poly bottle or other appropriate container and label the container as director in Section 2.2.7. The algae must be kept cool to prevent spoilage.

2.4.8 Fish

Fish are obtained three times per year (March, August and December) as available either from the traveling screens as washed into the fish basket or by other methods as required. For any given sampling period, three fish, or a sufficient number to yield at least 1000 gm of fillets, should be provided.

Place fish in plastic bags and tape and/or tie tightly closed. Fish are stored briefly in a radiologically clean freezer. It may be desirable in warm weather to coordinate milk and fish sampling, thereby allowing simultaneous shipment in insulated containers. Pack fish samples with ice if needed. Label bags as directed in Section 2.2.7, being sure to indicate fish species when possible. Following packaging of fish, remove and discard any fish left in the freezer. This avoids sending fish that are not representative of the sampling period.

Fish are obtained four times per year (March, June, September and December) for the State of Wisconsin. Fish sampling for the State is performed in the same manner as that for the plant. Approximately four fish should be sent to the state at each sampling period.

2.4.9 Soil

Soil integrates atmospheric deposition and acts as a reservoir for long-lived radionuclides. Although soil sampling is a poor technique for assessing small incremental releases and for monitoring routine releases, it does provide a means of monitoring long-term trends in atmospheric deposition in the vicinity of PBNP. Therefore, soil samples are obtained two times per year from specified locations.

Clear the vegetation from a 6" x 6" area, being careful to leave the top layer of soil relatively intact. Remove root bound soil by shaking the soil onto the cleared area or into the sample container before discarding the roots. When necessary, it is preferable to leave some roots in the soil rather than to lose the top layer of soil.

Remove the soil to a depth of three inches. If necessary, expand the area, instead of digging deeper, to obtain the required amount of sample. If an area larger than 6" x 6" is used, notify NSA of the area used. The minimum acceptable quantity is 500 grams. Place the entire soil sample in a wide-mouth poly bottle or another appropriate container. If a plastic bag is used, seal the bag with tape. Label the sample as directed in Section 2.2.7.

This procedure assumes that the samples are obtained from undisturbed land; land that has not been plowed within approximately the last 25 years. If the land has been plowed, the soil should be sampled to the plow depth which typically is eight inches. Place the soil in a clean bucket or appropriate size plastic bag, homogenize the soil and place 1000 grams of the well mixed soil sample in a plastic bag, or other appropriate container, and label as described above.

2.4.10 Shoreline Sediment

Shoreline sediment consisting of sand and smaller grain size material is sampled two times per year from specified locations. The 1000 gram sample is collected, from beach areas near the water ridge. At each location collect representative samples of sediment types roughly in proportion to their occurrence. For example, at E-06 avoid collecting a sample which consists exclusively of the dark-brown to black sediments which occur in layers up to several inches thick. Package the sample in a wide-mouth poly bottle or other appropriate container and label as described in Section 2.2.7.

2.5 Milk Survey

The milk sampling program is reviewed annually, including a visual verification of animal grazing in the vicinity of the site boundary, to ensure that sampling locations remain as conservative as practicable. The verification is conducted each summer by cognizant PBNP personnel. Because it is already assumed that milk animals may graze up to the site boundary, it is only necessary to verify that these animals have not moved onto the site. No animal census is required. Upon completion of the visual check, RP personnel will notify NSA in writing. To ensure performance of the annual verification, "milk review" is identified on the sampling checklist (i.e., the PBF-4121a-l series).

TABLE 2-1
RECOMMENDED MINIMUM SAMPLE SIZES

Sample Type	Size
Vegetation	100-1000 gm
Lake Water	8 liters (2 gal)
Air Filters	250 m^3
Well Water	8 liters (2 gal)
Milk	8 liters (2 gal)
Algae	100-1000 gm
Fish (edible portions)	1000 gm
Soil	500-1000 gm
Shoreline Sediment	500-1000 gm

TABLE 2-2
SAMPLE TYPES AND ASSOCIATED LOWER LEVEL OF DETECTION (LLD) AND NOTIFICATION LEVEL VALUES

SAMPLE TYPE	REPORTING UNIT	PARAMETER	LLD[a]	NOTIFICATION LEVELS NRC (Regulatory)	NPBU[b] (Admin.)	WEIGHTED SUM ACTION LEVEL
Vegetation	pCi/g wet	Gross Beta	0.25	---	60	---
		Cs-137	0.08	2	0.40	0.50
		Cs-134	0.06	1	0.20	0.25
		I-131	0.06	0.1	0.06	0.06
		Other[c]	0.25	---	2.0	---
Shoreline Sediment and Soil	pCi/g dry	Gross Beta	2.0	---	100	---
		Cs-137	0.15	---	20	---
		Other[c]	0.15	---	20	---
Algae	pCi/g wet	Gross Beta	0.25	---	12	---
		Cs-137	0.25	10	1	2.5
		Cs-134	0.25	10	1	2.5
		Co-58	0.25	10	1	2.5
		Co-60	0.25	10	1	2.5
		Other[c]	0.25	---	1	---
Fish	pCi/g wet	Gross Beta	0.5	---	125	---
		Cs-137	0.15	2	0.40	0.50
		Cs-134	0.13	1	0.20	0.25
		Co-58	0.13	30	3	7.5
		Co-60	0.13	10	1	2.5
		Mn-54	0.13	30	3	7.5
		Fe-59	0.26	10	1	2.5
		Zn-65	0.26	20	2	5.0
		Other[c]	0.5	---	6	---
TLDs	mR/7 days	Gamma Exposure	1mR/TLD	---	5mR/7 days	---
Lakewater[e] and Well Water	pCi/L-T.S.[d]	Gross Beta	4	---	100	---
		Cs-134	15	30	15	15
		Cs-137	18	50	18	18
		Fe-59	30	400	40	100
		Zn-65	30	300	30	75
		Zr-Nb-95	15	400	40	100
		Ba-La-140	15	200	20	50
		Co-58	15	1,000	100	250
		Co-60	15	300	30	75

Table 2-2

SAMPLE TYPE	REPORTING UNIT	PARAMETER	LLD[a]	NOTIFICATION LEVELS NRC (Regulatory)	NPBU[b] (Admin.)	WEIGHTED SUM ACTION LEVEL
Lakewater and Well Water (Continued)	pCi/L-T.S.[d]	Mn-54	15	1,000	100	250
		I-131	2	---	2	---
		Other	30	---	100	---
		H-3	3,000	30,000	3,000	7,500
		Sr-89	10	---	50	---
		Sr-90	2	---	20	---
Milk	pCi/L	Sr-89	5	---	100	---
		Sr-90	1	---	100	---
		I-131	0.5	3	0.5	0.75
		Cs-134	15	60	15	15
		Cs-137	18	70	18	18
		Ba-La-140	15	300	30	75
		Other[c]	15	---	30	---
Air Filter	pCi/m^3	Gross Beta	0.01	---	1.0	---
		I-131	0.07	0.9	0.09	0.2
		Cs-137	0.06	20	2.0	5.0
		Cs-134	0.05	10	1.0	2.5
		Other[c]	0.1	---	1.0	---

(a) The LLDs in this column are the maximum acceptable values.
(b) The values in this column are not technical specifications.
(c) Other refers to non-specified identifiable gamma emitters.
(d) T.S. = total solids.
(e) No drinking water

TABLE 2-3
RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

Location Code	Location Description
E-01	Primary Meteorological Tower, South of the plant
E-02	Site Boundary Control Center - East Side of Building
E-03	Tapawingo Road, about 0.4 Miles West of Lakeshore Road
E-04	North Boundary
E-05	Two Creeks Park
E-06	Point Beach State Park - Water and shoreline sediment samples at the Coast Guard Station; soil and vegetation from the Point Beach State Park campground area N of the Coast Guard Station and on the W side of County Road O; TLD located South of lighthouse on telephone pole.
E-07	WPSC Substation on County Rt. V, about 0.5 Miles West of Hwy. 42
E-08	G. J. Francar Property, at the Southeast Corner of the Intersection of Cty. B and Zander Road
E-09	Nature Conservancy
E-10	PBNP Site Well
E-11	Dairy Farm (W. Funk), about 3.75 Miles West of Site
E-12	Discharge Flume/Pier
E-13	Pumphouse
E-14	South Boundary, about 0.2 miles East of Site Boundary Control Center
E-15	Southwest Corner of Site
E-16	WSW, Hwy. 42, Residence, about 0.25 miles North of Nuclear Road
E-17	North of Mishicot, Cty. B and Assman Road, Northeast Corner of Intersection
E-18	Northwest of Two Creeks at Zander and Tannery Roads
E-19	Local Dairy Farm, ~~about 0.2 miles West of Hwy. 42 on the North Side of Two Creeks Road (L. Engelbrecht)~~ No longer providing milk samples. August 2003.
E-20	Reference Location, 17 miles Southwest, at Silver Lake College
E-21	Local Dairy Farm just South of Site (L. Strutz) on Lakeshore and Irish Roads
E-22	West Side of Hwy. 42, about 0.25 miles North of Johanek Road
E-23	Greenfield Lane, about 4.5 Miles South of Site, 0.5 Miles East of Hwy. 42
E-24	North Side of County Rt. V, near intersection of Saxonburg Road
E-25	South Side of County Rt. BB, about 0.5 miles West of Norman Road
E-26	804 Tapawingo Road, about 0.4 miles East of Cty. B. North Side of Road
E-27	Intersection of Saxonburg and Nuclear Roads, Southwest Corner, about 4 Miles WSW
E-28	TLD on westernmost pole between the 2nd and 3rd parking lots,
E-29	Area of North Meterological Tower
E-30	NE corner at Intersection of Tapawingo and Lakeshore Roads.
E-31	On utility pole North side of Tapawingo Road closest to the gate at the West property line

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Table 2-3

Location Code	Location Description
E-32	On a tree located at the junction of property lines, as indicated by trees and shrubs, about 500 feet east of the west gate in line with first designated treeline on Tapawingo Road and about 1200 feet south of Tapawingo Road. The location is almost under the power lines between the blue and gray transmission towers.
E-33	Lake Michigan shoreline accessed from SE corner of KNPP parking lot. Sample south of creek.
E-38	Retention Pond fence, W side.
E-39	Retention Pond fence, E side.
E-TC	Transportation Control; Reserved for TLDs
E-40	Local Dairy Farm, about 1.8 miles north of intersection of Highway 42 and Nuclear Road (Manitowoc County), on west side of Highway 42.

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TABLE 2-4
PBNP RADIOLOGICAL ENVIRONMENTAL SAMPLE COLLECTION AND ANALYSIS FREQUENCY

Sample Type	Sample Codes	Analyses	Frequency
Environmental Radiation Exposure	E-01, -02, -03, -04, -05 -06, -07, -08, -09, -12 -14, -15, -16, -17, -18, -20, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -32, -38, -39, -TC	TLD	Quarterly
Vegetation	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Algae	E-05, -12	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Fish	E-13	Gross Beta Gamma Isotopic Analysis (Analysis of edible portions only)	3x/yr as available
Well Water	E-10	Gross Beta, H-3 Sr-89, 90, I-131 Gamma Isotopic Analysis (on total solids)	Quarterly
Lake Water	E-01, -05, -06 -33	Gross Beta H-3, Sr-89, 90 I-131 Gamma Isotopic Analysis (on total solids)	Monthly Quarterly composite of monthly collections Monthly Monthly
Milk TCN 2003-0828	E-11, ~~-19~~, -21, -40	Sr-89, 90 I-131 Gamma Isotopic Analysis	Monthly
Air Filters	E-01, -02, -03, -04, -08, -20	Gross Beta I-131 Gamma Isotopic Analysis	Weekly (particulate) Weekly (charcoal) Quarterly (on composite particulate filters)
Soil	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	2x/yr
Shoreline Sediment	E-01, -05, -06, -12, -33	Gross Beta Gamma Isotopic Analysis	2x/yr

TABLE 2-5
SAMPLES COLLECTED FOR STATE OF WISCONSIN

	Sample Type	Location	Frequency
1.	Lake Water	E-01	Monthly
2.	Air Filters	E-07 E-08	Weekly
3.	Fish	E-13	Quarterly, As Available
4.	Precipitation	E-04 E-08	Twice a month, As Available
5.	Milk	E-11 E-~~12~~ 40	Monthly
6.	Well Water	E-10	2 times/year

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FIGURE 2-1a
RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

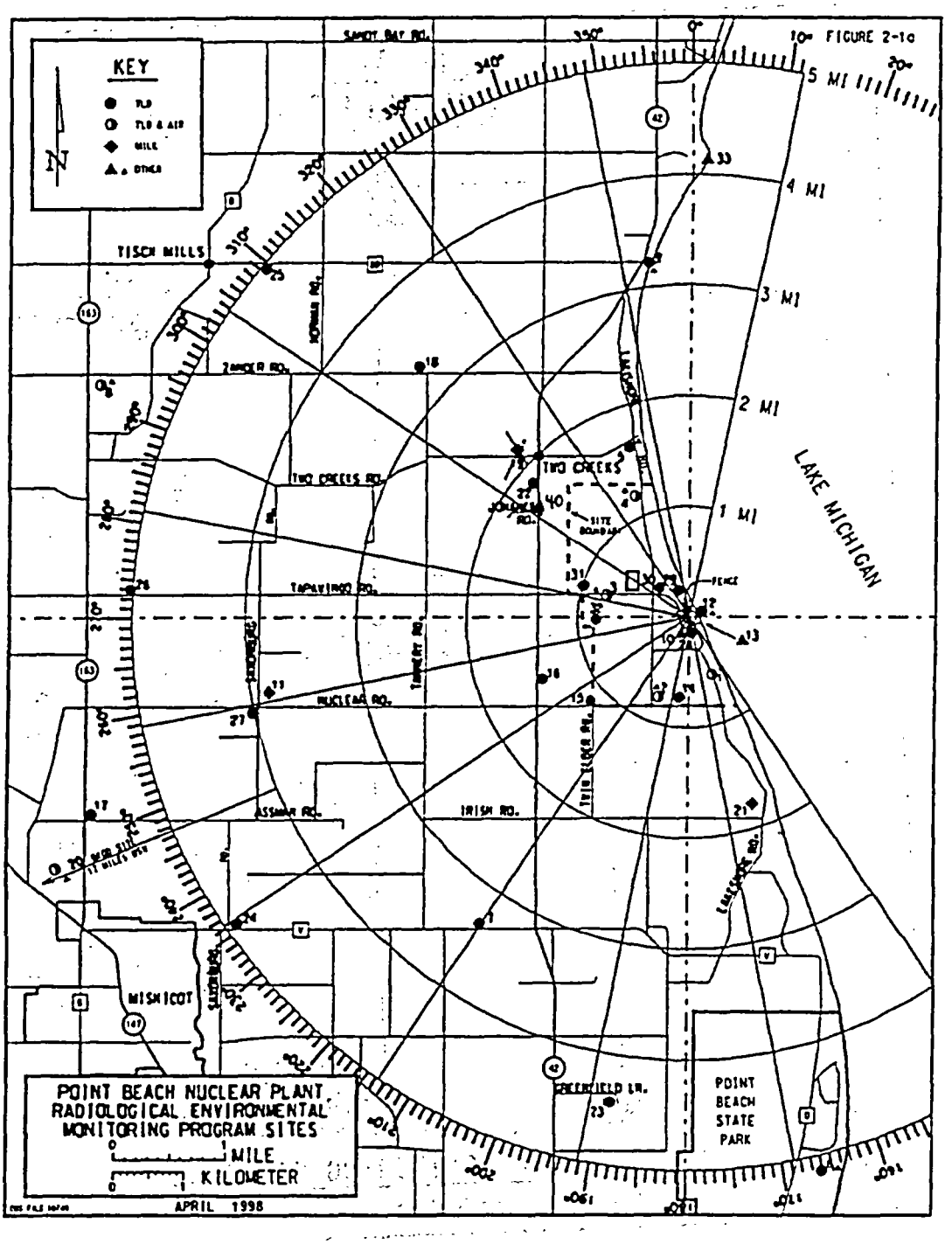

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FIGURE 2-1b
RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS

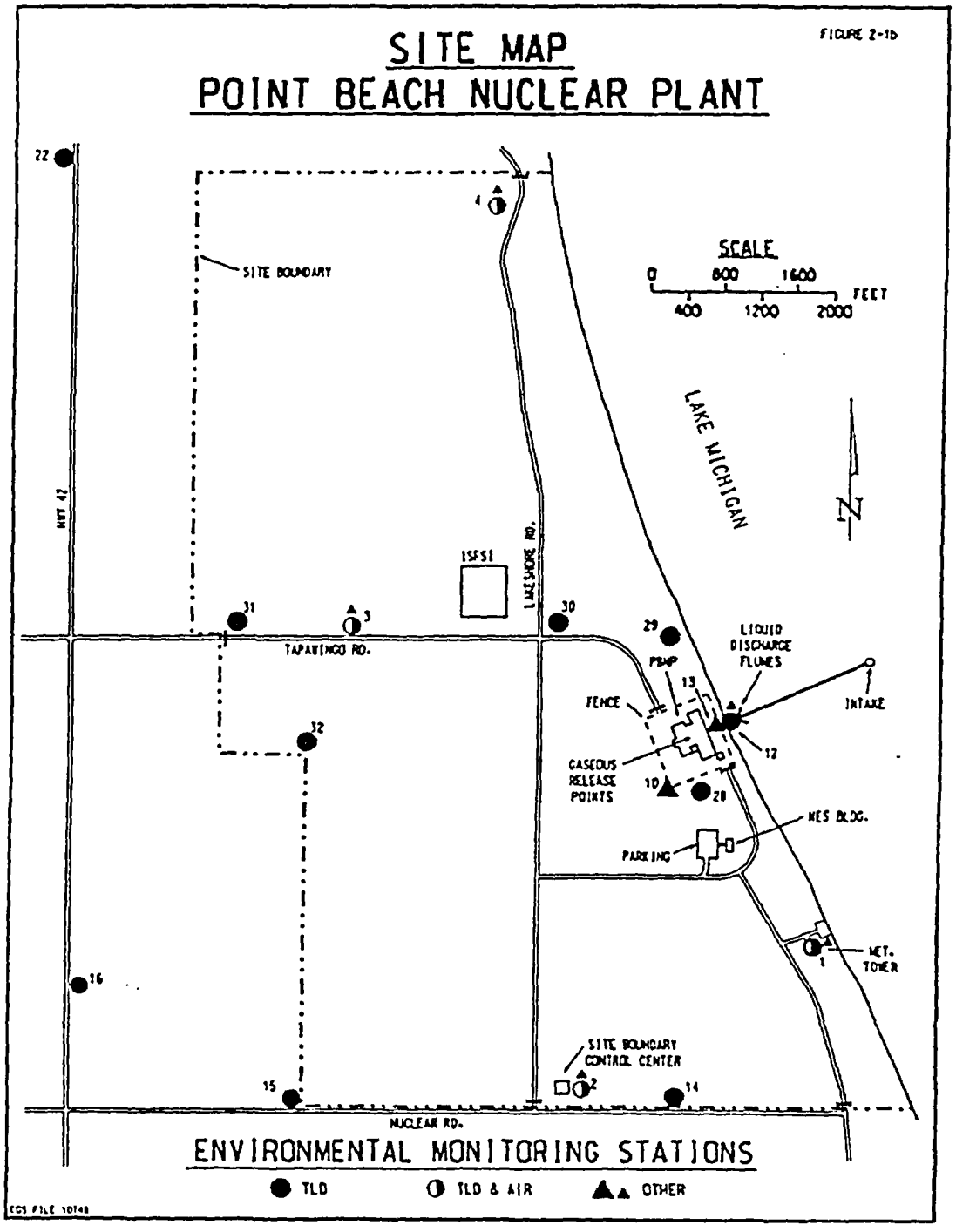
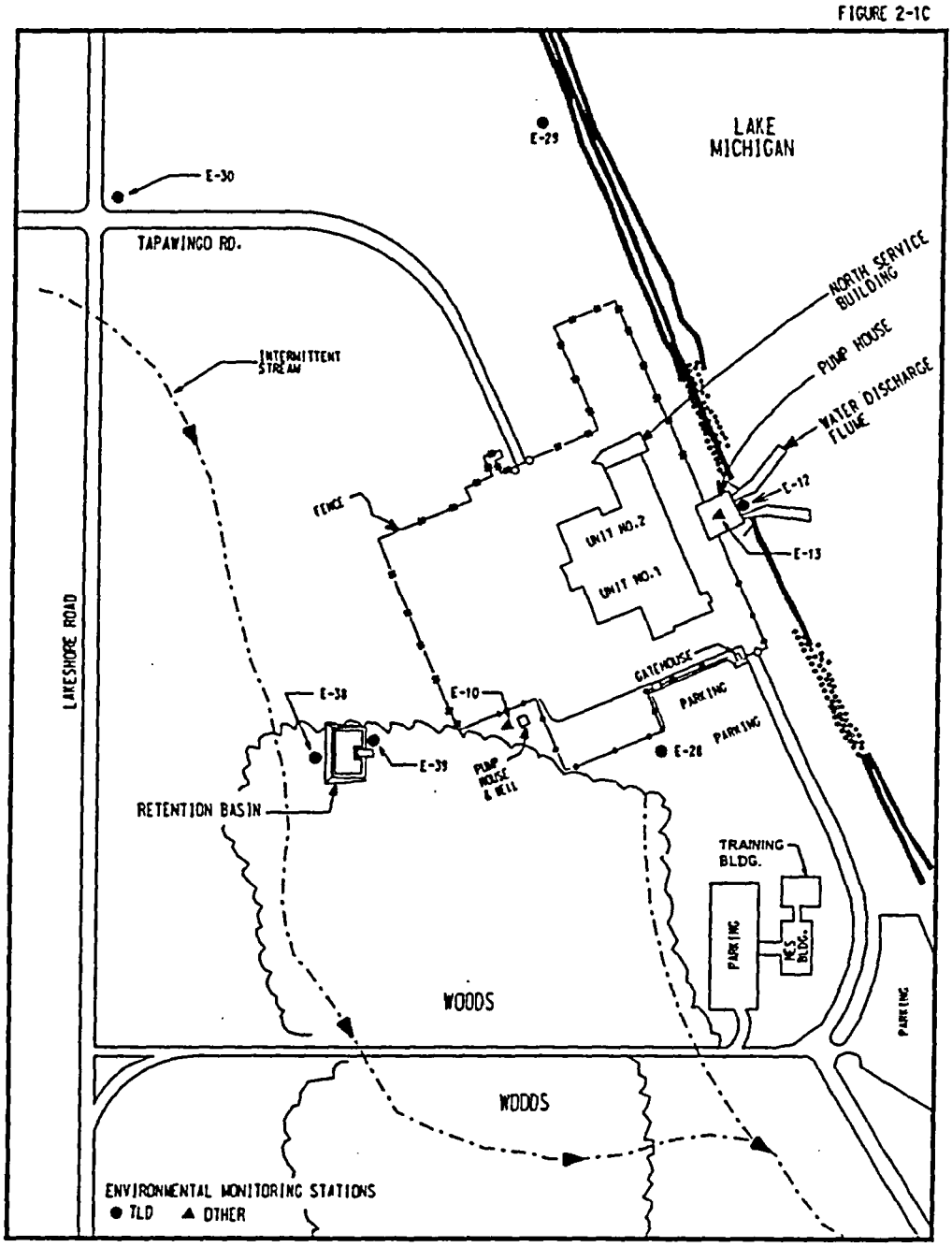


FIGURE 2-1c
RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS



ODCM

OFFSITE DOSE CALCULATION MANUAL

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1.0 OFFSITE DOSE CALCULATION MANUAL ADMINISTRATION

1.1 Purpose

The PBNP Offsite Dose Calculation Manual contains the current methodology and parameters for the calculation of offsite doses due to radioactive gaseous and liquid effluents. This manual describes a methodology for demonstrating compliance with 10 CFR 50, Appendix I dose limits. Compliance with Appendix I is demonstrated by periodic calculation of offsite doses based on actual plant releases and comparison to Appendix I dose limits.

The manual also details the methodology for the determination of gaseous and liquid effluent monitor alarm set points. The PBNP Radiation Monitoring System (RMS) effluent monitor alarm set points are established to ensure that controlled releases of liquid and gaseous radioactive effluents are maintained as low as is reasonably achievable. The setpoints also are established to ensure that concentrations of radioactive material released in effluents to the atmosphere do not exceed the values of Table 2, Column 1, of Appendix B to 10 CFR 20.1001-20.2402 at or beyond the site boundary and to ensure that the concentrations of radioactive materials released in liquid effluents to the unrestricted area conform to (do not exceed) 10 times the concentration values in Table 2, Column 2 of Appendix B to 10 CFR 20.1001-20.2402.

The manual also details the methodology for evaluating the radiological impact of sewage treatment sludge disposal. This methodology addresses the commitments made to the United States Nuclear Regulatory Commission in our application dated October 8, 1987 (NRC-87-104) and accepted by the USNRC in a letter dated January 13, 1988. This application was submitted in accordance with the provisions of 10 CFR 20.302(a). Dose limits are established in the application to ensure the health and safety of the maximally exposed member of the general public and the inadvertent intruder. 10 CFR 50, Appendix I dose limits do not apply to sewage treatment sludge disposal.

1.2 General Responsibilities

The primary responsibility for the implementation of the PBNP offsite dose calculation program and for any actions required by the program resides with the Nuclear Safety Analysis Group (NSA). NSA will provide the technical, regulatory, licensing, and administrative support necessary to fulfill the requirements of this manual. The calculation of offsite doses and analysis of data are NSA responsibilities.

The Manager, PBNP is responsible for assuring that Radiation Monitoring System alarm set points are established and maintained in accordance with the methodologies outlined in this manual. The Manager, PBNP is also responsible for assuring the performance of periodic release summaries for the purpose of demonstrating compliance with PBNP effluent release limits.

1.3 Manual Revisions

Per TS 5.5.1.C, licensee initiated changes to the Offsite Dose Calculation Manual (ODCM) shall be documented and records of reviews performed shall be retained. This documentation shall contain sufficient information to support the changes(s) together with the appropriate analyses or evaluations justifying the changes(s), and a determination that the change(s) maintain the levels of radioactive effluent control required by 10 CFR 20.1302, 40 CFR 190, 10 CFR 50.36a, and 10 CFR 50, Appendix I, and do not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations. These changes shall become effective after receiving concurrence PBNP Manager's Supervisory Staff (MSS) and approval of the Plant Manager, and shall be submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Annual Monitoring Report for the period of the report in which any change in the ODCM was made. Each change shall be identified by markings in the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (i.e. month and year) the change was implemented.

1.4 Audits

An audit of the activities encompassed by the ODCM, the Radiological Effluent Control Program, and the Radiological Environmental Monitoring Program and its implementing procedures shall be performed. Planning and scheduling of audits of the ODCM shall be performed in accordance with site Quality Assurance Program procedures. The results of the audit shall be transmitted to the Chief Nuclear Officer and the Chairman of the Offsite Review Committee.

2.0 RADIATION MONITORING SYSTEM AND RELEASE ACCOUNTING

A computerized Radiation Monitoring System (RMS) is installed at Point Beach Nuclear Plant (PBNP). The RMS includes area, process, and effluent monitors. A description of those monitors used for liquid and gaseous effluents is presented in Tables 2-1 and 2-2. The liquid and gaseous waste processing flow paths, equipment, and monitoring systems are depicted in Figures 2-1 and 2-2. Calibration of the RMS detectors is accomplished in accordance with procedures contained in the PBNP Health Physics Calibration Manual. The set point methodology is described in Section 3 of this manual.

The RMS is designed to detect and measure liquid and gaseous releases from the plant effluent pathways. The RMS will initiate isolation and control functions on certain effluent streams identified in Tables 2-1 and 2-2. Complete monitoring and accounting of nuclides released in liquid and gaseous effluents is accomplished with the RMS together with the characterization of nuclide distributions by laboratory analysis of grab samples. Sampling frequencies and analysis requirements are described in Tables 6-1 and 6-2 of the Radiological Effluent Control Manual. The various aspects of grab sampling and release accountability are described in the PBNP Release Accountability Manual.

OFFSITE DOSE CALCULATION MANUAL

TABLE 2-1
RADIOACTIVE LIQUID WASTE EFFLUENT MONITORS

CHANNEL NUMBER	NAME	CONTROL FUNCTION	DETECTOR TYPE
1 (2) RE-216	Containment Fan Coolers Liquid Monitors	None	Scintillation
RE-218	Waste Disposal System Liquid Monitor	Shuts waste liquid overboard	Scintillation
1 (2) RE-219	Steam Generator Blowdown Liquid Monitors	Shuts steam generator blowdown isolation valves, blowdown tank outlet valves and steam generator sample valves	Scintillation
RE-220	Spent Fuel Pool Liquid Monitor	None	Scintillation
RE-223	Waste Distillate Overboard Liquid Monitor	Shuts waste distillate overboard isolation valve	Scintillation
1 (2) RE-229	Service Water Discharge Monitors	None	Scintillation
RE-230	Waste Water Effluent Monitor	None	Scintillation
1 (2) RE-222	Steam Generator Blowdown Tank Outlet Monitor	Shuts steam generator blowdown isolation valves and blowdown tank outlet valves	GM Tube

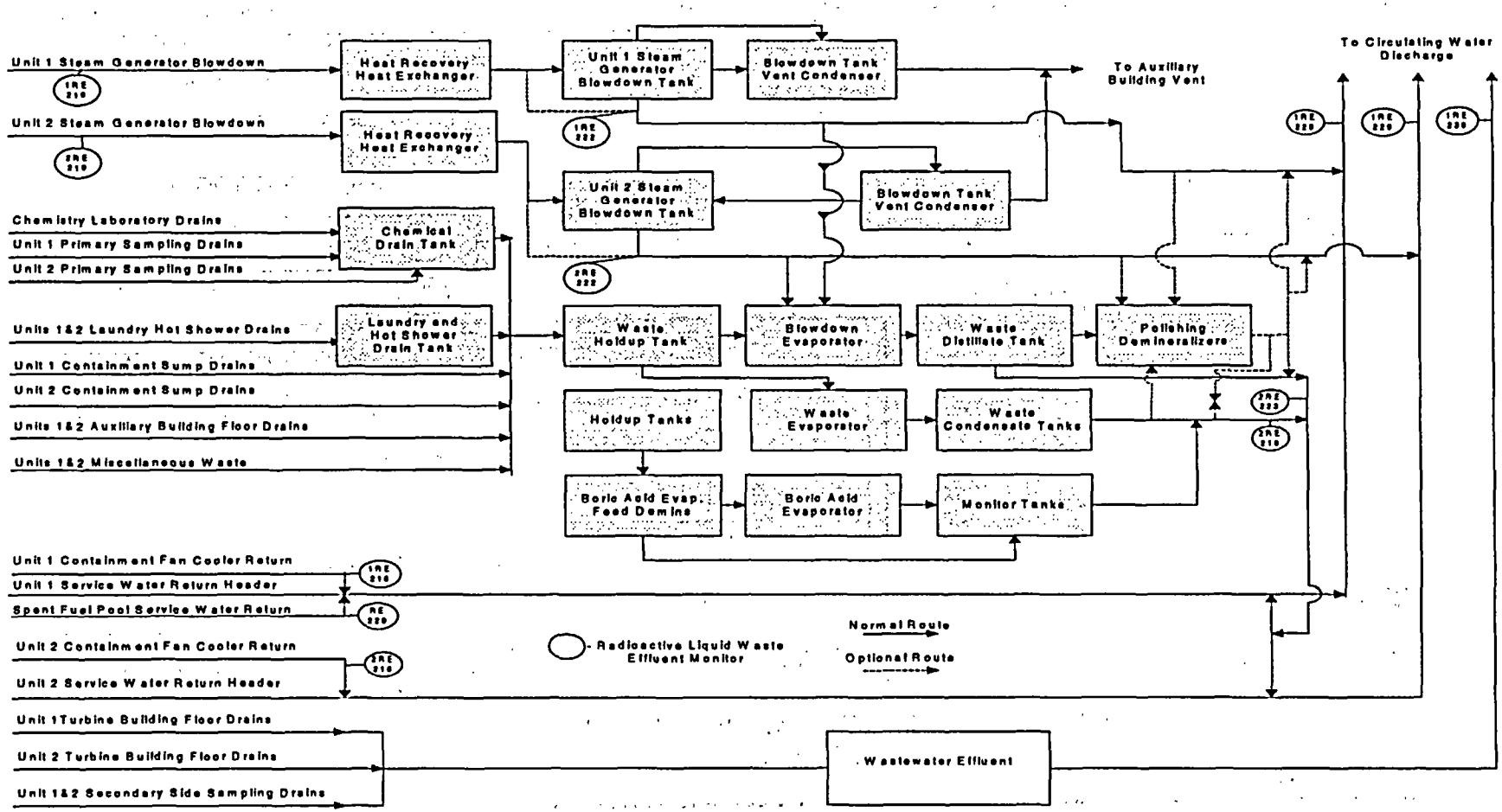
OFFSITE DOSE CALCULATION MANUAL

TABLE 2-2
RADIOACTIVE GASEOUS WASTE EFFLUENT MONITORS

CHANNEL NUMBER	NAME	CONTROL FUNCTION	DETECTOR TYPE
1 (2) RE-212	Containment Noble Gas Monitor	Actuates containment ventilation isolation	Scintillation
RE-214	Auxiliary Building Exhaust Ventilation Noble Gas Monitor	Shuts gas release valve and shifts auxiliary building exhaust through carbon filters	Scintillation
1 (2) RE-215	Condenser Air Ejector Noble Gas Monitors	None	Scintillation
RE-225	Combined Air Ejector Low-Range Noble Gas Monitor	None	Scintillation
RE-221	Drumming Area Vent Noble Gas Monitor	None	Scintillation
RE-224	Gas Stripper Building Exhaust Noble Gas Monitor	None	Scintillation
1 (2) RE-305	Unit 1 and 2 Purge Exhaust Noble Gas Monitors (Channel 5 on SPING Units No. 21 and No. 22)	Containment ventilation isolation	Scintillation
RE-315	Auxiliary Building Exhaust Ventilation Noble Gas Monitor (Channel 5 on SPING Unit No. 23)	None	Scintillation
RE-325	Drumming Area Ventilation Noble Gas Monitor (Channel 5 on SPING Unit No. 24)	None	Scintillation

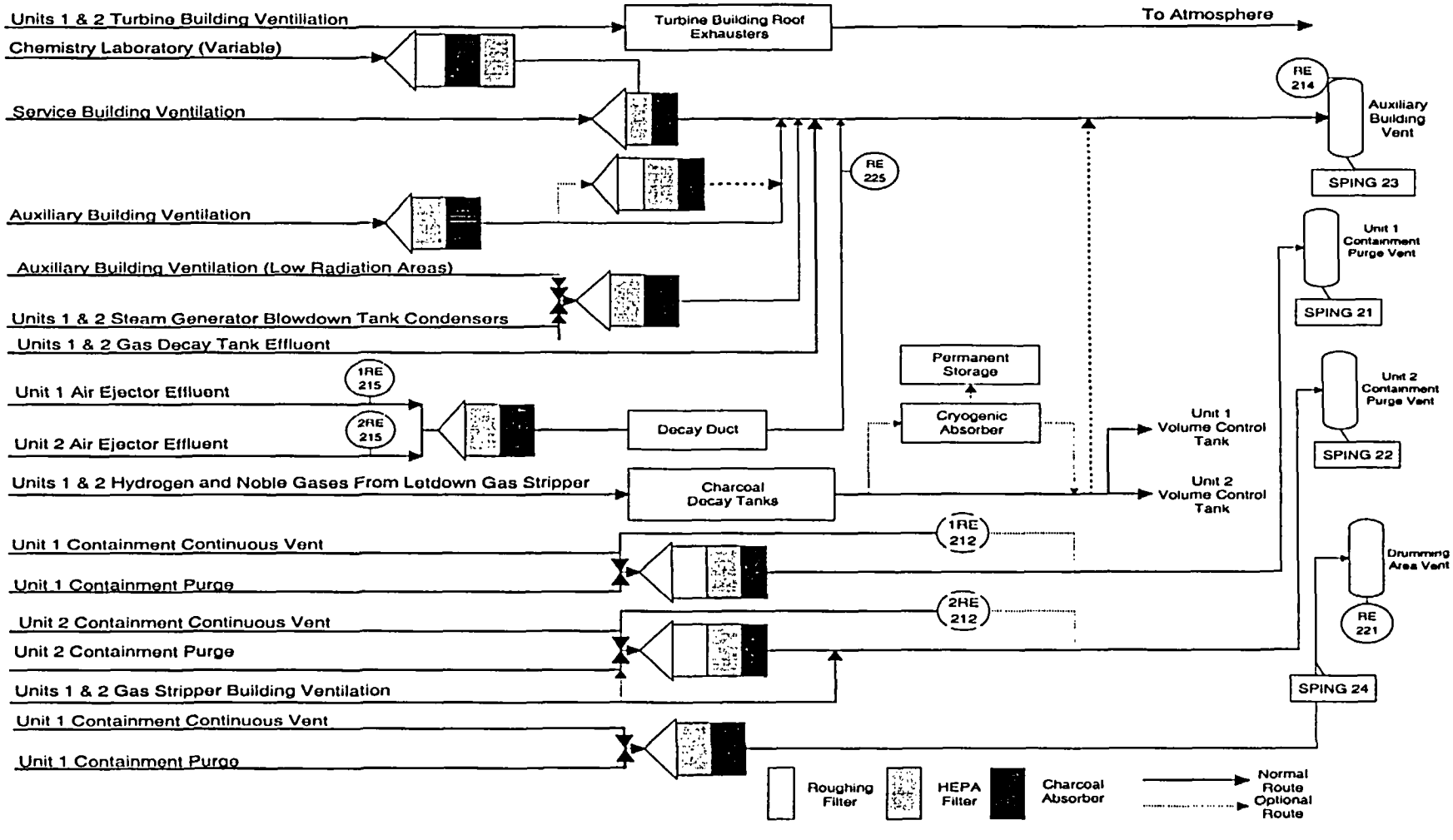
OFFSITE DOSE CALCULATION MANUAL

FIGURE 2-1
RADIOACTIVE LIQUID WASTE EFFLUENT MONITORS



OFFSITE DOSE CALCULATION MANUAL

FIGURE 2-2
RADIOACTIVE GASEOUS WASTE EFFLUENT MONITORS



3.0 METHODOLOGY FOR DETERMINING ALARM SET POINTS

3.1 Introduction

The selection and maintenance of alert and alarm set points for each effluent monitor of the PBNP radiation monitoring system will be accomplished within the guidelines of this section. The computerized PBNP radiation monitoring system permits each effluent radiation monitor to be programmed to alarm at two distinct set-points. The alert set point, typically twice the steady-state reading, is intended to delineate a changing plant condition which may warrant corrective action. The high alarm or trip set point either will actuate a control function as applicable or will require corrective action to be initiated.

3.2 Objective

The effluent monitor set points are established to ensure that controlled releases of liquid and gaseous radioactive effluents are maintained as low as is reasonably achievable, to ensure releases result in concentrations to unrestricted areas within specified limits and to ensure that the dose limits of 10 CFR 50, Appendix I are not exceeded.

3.3 Alert Set Point Guidelines

The alert set point of each effluent monitor generally will be set to alarm at two times the established steady-state reading. The alert set point is normally set at concentrations well below the alarm set point value and is never to be set in excess of the alarm set point. In the course of plant operations, certain situations may require a deviation from the two times steady-state guideline. The intent of the alert set point is to warn of changing plant conditions which may warrant an evaluation of the cause of the increased radiation. If the increased reading is actually due to an increased radiation inventory within the system being monitored, as opposed to an increased background radiation field in the vicinity of the detector, an evaluation should be made to determine the impact of the release. The alert set point may be adjusted with the approval of the Duty Shift Superintendent. Alert set point adjustments are to be made in accordance with the PBNP RMS Alarm Set Point and Response Book.

3.4 Alarm or Trip Set Point Guidelines

In accordance with the requirements of 10 CFR 20.1001 - 20.2402 and TS stated in Section 5 of the Radiological Effluent Control Manual, the alarm or trip set point for effluent monitors shall be established to annunciate at radiation levels which would result in an unrestricted area concentration equal to or less than the applicable maximum effluent concentration (MEC) for a single radionuclide. However, for a mixture of radionuclides, the set point shall be established so that the summation of fractions, as defined in Appendix B of 10 CFR 20 (see Section 3.6), is less than or equal to one (1). The appropriate detailed response to an effluent alarm is described in the PBNP RMS Alarm Set Point and Response Book.

3.5 Monitor Calibration and Calibration Constant Determination

Calibration of the RMS effluent detectors is accomplished in accordance with procedures contained in the PBNP Health Physics Calibration Manual. Noble gas effluent monitors apply the calibration constant to standardize all gaseous releases to the 1985-1991 average isotopic noble gas distribution. The calibration constants are based on the calculated monitor response to the beta energy distribution in the 1985-1991 average isotopic noble gas distribution.

Noble gas effluent monitor calibration constants are derived from the following formulae:

$$\text{Cal. Constant} = \frac{1}{\text{Sensitivity}}$$

and

$$\text{Sensitivity} = \frac{\text{Monitor Response}}{\Sigma(\text{microCi/cc}_i)}$$

where:

Monitor response	=	the calculated counts per minute registered by monitor exposed to the 1985-1991 average noble gas isotopic distribution
$\Sigma(\mu\text{Ci/cc}_i)$	=	total concentration of isotopes in the 1985-1991 average noble gas isotopic distribution

The liquid effluent monitors apply the derived calibration constant to standardize all liquid releases to the total concentration in the release path. The calibration constants are based on the monitor response to the 1985-1991 average liquid isotopic distribution. Each liquid monitor channel displays the effluent concentration in terms of a total release concentration.

Liquid effluent monitor calibration constants are derived from the following formulae:

$$\text{Cal. Constant} = \frac{1}{\text{Sensitivity}}$$

and

$$\text{Sensitivity} = \frac{Monitor\text{Re}sponse}{\Sigma(\mu Ci/cc_i)}$$

where:

Monitor Response = the counts per minute registered by monitor exposed to calibration source

$\Sigma(\mu Ci/cc_i)$ = total concentration on radionuclides in the 1985-1991 average liquid effluent isotopic distribution

The QAD computer program may be utilized to predict or determine monitor calibration constants. Application of the QAD program may be appropriate for determining monitor response for accident source terms or other instances when the use of a calibration source is impracticable. The methodology for determination of calibration constants using the QAD program is maintained by the staff of the NSA.

3.6 Determination of the Effective Maximum Effluent Concentration (EMEC) for Liquid Releases

Pursuant to PBNP TS, the concentration of radioactive materials in liquid effluent may not exceed 10 times the values of Column 2, Table 2, of Appendix B to 10 CFR 20.1001-20.2402. However, as a conservative measure, the following determination of the EMEC and the subsequent setpoint determination for liquid effluent (Section 3.7) do not employ the augmented concentration values.

In order to fulfill the requirements of 10 CFR 20, the RMS set point must be a value which will alarm when a liquid effluent would contain enough radionuclides to cause the effluent concentration limit of 10 CFR 20, Appendix B, Table 2, Column 2 for a single radionuclide to be exceeded, or for a mixture of radionuclides, the summation of fractions (SOF), as defined in Appendix B, to exceed one (1). Dividing the average isotopic concentrations for the years 1985-1991 by the SOF scales the total of individual concentrations up to the value where the SOF equals one. This total concentration is called the effective maximum effluent concentration (EMEC) and its calculation is described below. (For a complete discussion of the EMEC derivation, see Appendix A.)

The SOF is calculated using the formula found in the revised 10 CFR 20, Appendix B, Note 4:

$$SOF = \Sigma C_i/MEC_i$$

where:

C_i = concentration of radionuclide "i" (μCi/ml) in effluent (annual discharge/total volume of discharge)

MEC_i = maximum effluent concentration for unrestricted areas from Appendix B, Table 2, Column 2 of the revised 10 CFR 20.

The SOF for radionuclides in liquid effluent for the years 1985 through 1991 were averaged and applied to the average of the isotopic concentrations for the same years. Na-24 and H-3 were not used in the calculations (see Appendix A for details).

Next, the "effective MEC" or EMEC is calculated using the formula:

$$EMEC = \Sigma C_i / \Sigma (C_i/MEC_i) \text{ or } \Sigma C_i * 1/SOF$$

where the variables are the same as defined above.

The average EMEC, based on 1985-1991 data is 4.29E-06 µCi/cc. This is the maximum non H-3 radionuclide mixture concentration that could be released in liquid effluent without the SOF exceeding one (1).

However, the 10 CFR 20, Appendix B criterion is that the SOF for all radionuclides, including H-3 which cannot be measured by the liquid effluent NaI RMS monitors, be less than or equal to one (1). Therefore, the above equation modified by a factor of 0.70 (see Appendix A) to account for H-3 becomes

$$EMEC = 0.70\, \Sigma C_i / \Sigma (C_i/MEC_i) \quad \text{or} \quad \Sigma C_i * 0.70/SOF.$$

The EMEC becomes

$$EMEC = 0.70 * 4.29E\text{-}06 = 3.00E\text{-}06\ \mu Ci/cc.$$

Only three radionuclides identified in PBNP liquid effluent have a lower MEC (10 CFR 20, Appendix B, Table 2). They are I-131 (1E-06), Cs-134 (9E-07), and Cs-137 (1E-06).

Note that the use of the 0.7 modifying factor sets the SOF for non-tritium radionuclides to 0.7 and allows an SOF of 0.3 for H-3. A SOF of 0.3 limits the discharge concentration of H-3 to 0.3 MEC or 3E-04 µCi/cc. The factor of 0.3 may be changed as needed for releases for which the isotopic mixture and concentrations are known as long as the total SOF $\leq$1.

3.7 Determination of Liquid Effluent Monitor Alarm Set Point

The alarm set point for each liquid monitor is based upon the 1985-1991 average radionuclide concentration in the effluent discharged to the unrestricted area. The radionuclide concentration in the release is calculated assuming a minimum circulating water flow rate of 206,000 gpm and the maximum flow rate of the individual liquid effluent waste stream. The isotopic distribution of the waste stream is obtained from the historical PBNP release data for the seven years mentioned above. Set points are determined such that the sum of all radionuclides in the mixture, when released into the circulating water system, will be maintained at or below the unrestricted area EMEC.

Set points are calculated using the formula

$$SP = EMEC * \frac{\text{Circ water flow rate (gpm)}}{\text{Waste Discharge Flow Rate (gpm)}}$$

where

SP = RMS alarm set point in μCi/cc

EMEC = effective maximum effluent concentration

Circ water flow rate = total flow from Unit 1 + Unit 2

Waste discharge flow rate = flow rate for effluent line on which the monitor is located

Maximum waste discharge flow rates and monitors associated with each liquid effluent pathway are described in Table 3.7-1.

Default alarm set points normally are established based upon the maximum waste discharge flow rate and the minimum circulation water flow rate. The liquid release monitor default set points are listed in Table 3.7-2. Alarm set points may be adjusted for batch releases, when actual flow rates are known. Alarm set point adjustments which are higher than default values, are to be made in accordance with the provisions and methodologies of this section and requires approval of the MSS. Lower alarm set point values maybe used without PORC approval if the default values lie outside the upper range of the monitor or if compliance with applicable limits will not be compromised.

TABLE 3.7-1
SUMMARY OF LIQUID DILUTION AND EFFLUENT PATHWAY FLOW RATES

LIQUID EFFLUENT PATHWAY	DISCHARGE FLOW RATE (GPM)	PATHWAY MONITOR
RECIRCULATION WATER		
1 pump, either unit	206,000	None
2 pumps, either unit	350,000	
1 pump, each unit	392,000	
1 pump, one unit & 2 pumps, other unit	530,000	
2 pumps, each unit	680,000	
SERVICE WATER RETURN (normal cooldown per pump		1 (2) RE-229
2 pumps @ 7500 gpm	15,000	
3 pumps @ 6300 gpm	18,900	
4 pumps @ 5100 gpm	20,400	
5 pumps @ 4300 gpm	21,500	
6 pumps @ 3700 gpm	22,200	
STEAM GENERATOR BLOWDOWN		1 (2) RE-219 & 1 (2) RE-222
Max flow	200	
WASTE WATER EFFLUENT		RE-230
Max Flow Rate (both filter skids running in parallel)	600	

TABLE 3.7-1, cont
SUMMARY OF LIQUID DILUTION AND EFFLUENT PATHWAY FLOW RATES

LIQUID EFFLUENT PATHWAY	DISCHARGE FLOW RATE (GPM)	PATHWAY MONITOR
SPENT FUEL POOL		RE-220
Max Flow Rate	700	
WASTE DISTILLATE & CONDENSATE TANK DISCHARGE		RE-218 & RE-223
Max Flow Rate	100	
CONTAINMENT FAN COOLER RETURN		1 (2) RE-216
Max Flow Rate per Containment	4000	

TABLE 3.7-2
LIQUID PATHWAY MONITOR
CALCULATED DEFAULT SET POINTS

MONITOR	FLOWRATE (gpm)	SET POINT (μCi/cc)
1 (2) RE-229	6 @ 3700[1]	2.78E-05
1 (2) RE-219 & 1 (2) RE-222	200	3.09E-03
RE-230	600	1.03E-03
RE-220	700	8.83E-04
RE-218 & RE-223	100	6.18E-03
1 (2) RE-216	4000	1.55E-04

[1] six service water pumps at normal cooldown flow rates

3.8 Determination of EMEC for Atmospheric Releases

The maximum concentration of the mixture of radionuclides that is allowable at the site boundary is called the effective maximum effluent concentration (EMEC). The EMEC for an effluent mixture is defined by the equation

$$EMEC = \Sigma C_i / \Sigma(C_i / MEC_i)$$

where

C_i = concentration of radionuclide "i"

MEC_i = maximum effluent concentration for radionuclide i from 10 CFR 20, Appendix B, Table 2

$\Sigma (C_i / MEC_i)$ = summation of fractions (SOF), as discussed in Section 3.6, applied to atmospheric releases

The EMEC is calculated from the reference radionuclide mixture. This mixture is obtained from the 1985 - 1991 average annual atmospheric releases and the corresponding concentrations determined from the highest annual average χ/Q. (Details of the EMEC calculation are found in Appendix B.)

The calculated EMEC, corrected for H-3, of 1.92E-08 μCi/cc was obtained to be used in the set point calculations.

3.9 Determination of Gaseous Effluent Monitor Alarm Set points

The alarm set point for each monitor is based upon maintaining the concentration of the reference radionuclide mixture at or below the EMEC. The set point is calculated using the formula

$$SP = 2.12E+03 * EMEC / (\chi/Q * FR)$$

where

SP = set point in μCi/cc

2.12E + 03 = conversion factor for ft^3/min to m^3/sec

EMEC = 1.92E-08 μCi/cc

χ/Q = highest site boundary annual average 1.5E-06 sec/m^3

FR = the flow rate in ft^3/min of the effluent pathway being monitored.

Combining the above numerical values yields

$$SP(\mu Ci/cc) = 2.71E + 01 / FR$$

Gaseous effluent pathway discharge flow rates and monitors associated with each pathway are summarized in Table 3.9-1.

TABLE 3.9-1
SUMMARY OF GASEOUS EFFLUENT PATHWAY DISCHARGE FLOW RATES

GASEOUS EFFLUENT PATHWAY		DISCHARGE FLOW RATE CFM	MONITOR(S) IN EFFLUENT PATHWAY
a.	Auxiliary Building Vent	66,400	RE-214 & SPING 23
b.	Combined Air Ejector	20	RE-225
c.	Unit Air Ejector	10	1 (2) RE-215
d.	Containment Purge Vent		
	1) 1 fan operating	12,500	1 (2) RE-212 &
	2) 2 fans operating	25,000	SPINGS 21 & 22
e.	Gas Stripper Building	13,000	RE-224
f.	Drumming Area Vent	43,100	RE-221 & SPING 24

Alarm set points are to be normally established based upon maximum waste discharge flow rates and the highest annual average χ/Q value at the site boundary. The alarm set points may be adjusted for release periods if actual flow rates are reduced to less than maximum values or actual χ/Q values are calculated. Alarm set point adjustments to higher values are to be made in accordance with the provisions and methodologies of this section and require MSS approval. Default set point values obtained using the flow rates in Table 3.9-1 are presented in Table 3.9-2. An additional reduction factor of 1/4 has been applied to the four release point monitors so that the maximum allowable site boundary concentrations will not be exceeded in the event simultaneous releases from these points occur. Lower set point values may be used for any of the monitors without PORC approval if the default value is outside the upper range of the monitor or if compliance with applicable release limits will not be compromised. The set point values for the SPINGs will be the same as the corresponding release point monitor; RE-214 (SPING 23), 1(2)RE-212 (SPINGS 21 and 22) or RE-221 (SPING 24).

TABLE 3.9-2
ATMOSPHERIC PATHWAY MONITOR
DEFAULT RMS SET POINTS

MONITOR	FLOW RATE (ft^3/min)	SET POINT (μCi/cc)
RE-214	66,400	1.02E-04
RE-225	20	1.36E+00
1RE-215	10	2.71E+00
2RE-215	10	2.71E+00
1RE-212	25,000[1]	2.73E-04
2RE-212	38,000[2]	1.78E-04
RE-224	13,000	2.09E-03
RE-221	43,000	1.58E-04

[1] 2 fans (with 1 fan the flow rate is 12,500 cubic feet/minute)

[2] 2 fans + 13,000 cfm from the gas stripper building

3.10 Determination of Maximum Release Rates

Technical specifications restrict the rate of release of radionuclides to the atmosphere to that value, which if continued for one year, would result in the following annual dose rates at or beyond the site boundary: 500 mrem/yr to the whole body and 3000 mrem/yr to the skin from noble gases; and, 1500 mrem/yr to any organ from I-131, I-133, H-3, and particulates with a half-life >8 days.

3.10.1 Noble gas release rate

The release rate for noble gases are calculated using the Reg. Guide 1.109 dose factors and the annual average isotopic noble gas release for the years 1985 - 1991 as shown in Table B-1. Following the methodology in Section 5.1.3, the calculated annual skin dose from the average 1985 - 1991 isotopic mixture with a total of 4.51E+01 curies is 1.03E-02 mrem. Therefore the maximum release rate is calculated from the formula

Ci/sec = total Ci * dose limit / (sec/yr * dose from total Ci).

Based on skin dose, the release rate formula

Ci/sec = 4.51E+01 Ci * 3000 mrem/yr/ (3.15E+07 sec/yr * 1.03E-02 mrem) yields a release rate of 4.17E-01 Ci/sec.

Using the same total curies with the same isotopic mixture but with the whole body dose of 5.89E-03 mrem/yr and the whole body dose limit of 500 mrem/yr, the release rate becomes 1.22E-01 Ci/sec.

Therefore the whole body dose rate is limiting and the maximum allowable PBNP noble gas release rate is 1.22E-01 Ci/sec. This rate is higher than any PBNP noble gas release rate from 1985 - 1991 based on the highest reported hourly average release rates of approximately 4.3E-02 Ci/sec.

3.10.2 Release rate for I-131, I-133, H-3, and particulates released to the atmosphere with half-lives >8 days

During the time period of 1985 - 1991, PBNP released an annual average of 116.30457 Ci to the atmosphere consisting of I-131, I-133, H-3, and particulates whole half-life >8 days. Of this quantity, 116.30 was H-3 and 4.57E-03 was I-131, I-133, and particulates whose half-life was >8 days. The doses from this mixture, calculated using ODCM methodology are shown in Table 3.10.1.

Table 3.10-1 mrem from all radionuclides (1985 - 1991 average)

	mrem from all radionuclides (1985 - 1991 average)							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
ADULT	1.66E-02	3.68E-02	5.74E-02	5.44E-02	2.01E-02	1.42E-02	1.23E-02	3.27E-02
TEEN	2.69E-02	5.25E-02	5.57E-02	4.64E-02	2.56E-02	1.72E-02	1.29E-02	3.27E-02
CHILD	6.31E-02	8.30E-02	5.48E-02	7.70E-02	3.73E-02	2.31E-02	1.60E-02	3.27E-02
INFANT	5.04E-02	6.77E-02	3.58E-02	1.04E-01	2.00E-02	9.39E-03	2.59E-03	3.27E-02

If the 1985 - 1991 average isotopic effluent mixture released to the atmosphere is broken down into the following grouping: H-3, I-131 and I-133, and the remaining radionuclides, the groups contribution to the various organ doses are revealed (Tables 3.10-2 - 3.10-4).

Table 3.10-2 mrem from I-131 and I-133 (2.42E-03 Ci)

	mrem from I-131 AND I-133							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
ADULT	9.26E-05	1.32E-04	1.10E-04	4.31E-02	2.29E-04	0.00E+00	3.66E-05	4.20E-05
TEEN	8.52E-05	1.20E-04	9.82E-05	3.44E-02	2.06E-04	0.00E+00	2.50E-05	4.20E-05
CHILD	1.86E-04	1.88E-04	1.41E-04	6.17E-02	3.09E-04	0.00E+00	1.79E-05	4.20E-05
INFANT	2.63E-04	3.10E-04	1.71E-04	1.01E-01	3.62E-04	0.00E+00	1.17E-05	4.20E-05

Table 3.10-3 mrem from H-3 (116.3 Ci)

	mrem from H-3							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
ADULT	0.00E+00	1.13E-02	1.13E-02	1.13E-02	1.13E-02	1.13E-02	1.13E-02	0.00E+00
TEEN	0.00E+00	1.19E-02	1.19E-02	1.19E-02	1.19E-02	1.19E-02	1.19E-02	0.00E+00
CHILD	0.00E+00	1.53E-02	1.53E-02	1.53E-02	1.53E-02	1.53E-02	1.53E-02	0.00E+00
INFANT	0.00E+00	2.35E-03	2.35E-03	2.35E-03	2.35E-03	2.35E-03	2.35E-03	0.00E+00

Table 3.10-4 mrem from all radionuclides except H-3 and radioiodines (2.15E-03 Ci)

	mrem from all radionuclides except H-3 and radioiodines							
	Bone	**Liver**	**T. Body**	**Thyroid**	**Kidney**	**Lungs**	**GI-LLI**	**Skin**
ADULT	1.65E-02	2.53E-02	4.59E-02	2.08E-09	8.49E-03	2.84E-03	9.41E-04	3.27E-02
TEEN	2.68E-02	4.04E-02	4.37E-02	2.64E-09	1.35E-02	5.25E-03	9.76E-04	3.27E-02
CHILD	6.29E-02	6.75E-02	3.94E-02	4.94E-09	2.16E-02	7.81E-03	6.72E-04	3.27E-02
INFANT	5.01E-02	6.51E-02	3.32E-02	1.88E-09	1.73E-02	7.04E-03	2.27E-04	3.27E-02

As evident from Tables 3.10-1 through 3.10-4, H-3 contributes a significant portion of the thyroid dose for all age groups for the 1985 - 1991 mixture of radionuclides released to the atmosphere. Comparison of Tables 3.10-5 and 3.10-6 to Table 3.10-4 reveals that the major portion of the organ doses from radionuclides other than H-3 and radioiodines results from cobalt and cesium. Cs-134 and Cs-137 are the major dose contributors to the bone, liver, skin and kidneys whereas cobalt is the major contributor to the GI-LLI dose. Therefore, the dose results obtained from the 1985 - 1991 radionuclide mixture is consistent with the dose results from current effluents.

Table 3.10-5 mrem from Cs-134 and Cs-137 (1.84E-03 Ci)

	mrem from Cs-134 and Cs-137							
	Bone	**Liver**	**T. Body**	**Thyroid**	**Kidney**	**Lungs**	**GI-LLI**	**Skin**
ADULT	1.62E-02	2.53E-02	4.21E-02	0.00E+00	8.48E-03	2.82E-03	4.76E-04	2.84E-02
TEEN	2.64E-02	4.04E-02	3.98E-02	0.00E+00	1.35E-02	5.22E-03	5.52E-04	2.84E-02
CHILD	6.22E-02	6.74E-02	3.54E-02	0.00E+00	2.16E-02	7.78E-03	4.05E-04	2.84E-02
INFANT	5.01E-02	6.50E-02	2.95E-02	0.00E+00	1.73E-02	7.02E-03	1.96E-04	2.84E-02

Table 3.10-6 mrem from Co-57, Co-58, and Co-60 (1.93E-04 Ci)

	mrem from cobalts							
	Bone	**Liver**	**T. Body**	**Thyroid**	**Kidney**	**Lungs**	**GI-LLI**	**Skin**
ADULT	0.00E+00	2.24E-05	3.72E-03	0.00E+00	0.00E+00	2.32E-05	4.26E-04	4.32E-03
TEEN	0.00E+00	2.97E-05	3.73E-03	0.00E+00	0.00E+00	3.40E-05	3.88E-04	4.32E-03
CHILD	0.00E+00	4.35E-05	3.80E-03	0.00E+00	0.00E+00	2.76E-05	2.43E-04	4.32E-03
INFANT	0.00E+00	7.75E-06	3.69E-03	0.00E+00	0.00E+00	1.78E-05	1.86E-05	4.32E-03

Based on these results, the release rates for various radionuclide mixture can be determined using the methodology in Section 3.10.1.

For the total radionuclide mixture, the maximum release rate is

Ci/sec =1.16E+02 Ci *1500 mrem/yr/ (1.04E-01 mrem * 3.15E+07 sec/yr)

or 5.33E-02 Ci/sec,

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For radioiodines (I-131 and I-133), the maximum release rate is

Ci/sec =2.42E-03 Ci *1500 mrem/yr/ (1.01E-01 mrem * 3.15E+07 sec/yr)

or 1.14E-06 Ci/sec,

For H-3, the maximum release rate is

Ci/sec =1.16E+02 Ci *1500 mrem/yr/ (1.53E-02 mrem * 3.15E+07 sec/yr)

or 3.62E-01 Ci/sec,

For all radionuclides (other than H-3 and radioiodines) with a half-life > 8 days, the maximum release rate is

Ci/sec =2.15E-03 Ci *1500 mrem/yr/ (6.75E-02 mrem * 3.15E+07 sec/yr)

or 1.52E-06 Ci/sec,

For cesium (Cs-134, -137), the maximum release rate is

Ci/sec =1.84E-03 Ci *1500 mrem/yr/ (6.74E-02 mrem * 3.15E+07 sec/yr)

or 1.30E-06 Ci/sec,

For cobalt (Co-57, -58, -60), the maximum release rate is

Ci/sec =1.93E-04 Ci *1500 mrem/yr/ (4.26E-02 mrem * 3.15E+07 sec/yr)

or 2.16E-05 Ci/sec,

Finally, for the total of all radionuclides in the mixture except H-3, the maximum release rate is

Ci/sec =4.57E-03 Ci *1500 mrem/yr/ (1.01E-01 mrem * 3.15E+07 sec/yr)

or 2.15E-06 Ci/sec.

Because the limiting release rate is that of the radioiodines, a mixture of radionuclides whose half-lives is >8 days should be restricted to 1.14E-06 Ci/sec. However, if there is no I-131 and I-133, the cesium doses become limiting and the release rate limit may be raised to 1.30E-06 Ci/sec.

4.0 DEMONSTRATING COMPLIANCE WITH 10 CFR 50, APPENDIX I

4.1 Introduction

Maintaining effluents within the dose objectives of Appendix I is demonstrated at PBNP by periodic calculations. Compliance with Appendix I limits is demonstrated by periodically calculating doses to the maximum exposed individual using the methodology set forth in Regulatory Guide 1.109, Rev. 1, October 1977 and in other recognized sources such as ICRP publications.

In order to aid in the dose calculations, the formulae in Reg Guide 1.109 were rearranged to calculate the dose per curie released (mrem/Ci) to the environment. For each pathway given in Reg Guide 1.109, a radionuclide's mrem/Ci values for the whole body and the organs were calculated for each of the two release modes, liquid and atmospheric. All of the pathway doses for a radionuclide via the release mode under consideration were summed to obtain the radionuclide's total mrem/Ci released. These values, called total dose factors (TDFs), are listed in Tables 5.1.1 and 5.1.2. The application of TDFs are given in Section 5; the calculations used to obtain them, in Appendix C.

4.2 Dose Limits

To define the limits and conditions for the controlled release of radioactive materials in liquid and gaseous effluents to the environment, to ensure that these releases are as low as is reasonably achievable in conformance with 10 CFR Parts 50.34a and 50.36a, to ensure that these releases result in concentrations of radioactive materials in liquid and gaseous effluents released to unrestricted areas that are within the limits specified in 10 CFR 20, and to ensure that the releases of radioactive material above background to unrestricted areas are as low as is reasonably achievable, the following design release limits as defined in Appendix I to 10 CFR 50 apply:

A. The calculated annual total quantity of all radioactive material above background that may be released from each light-water-cooled nuclear power reactor to unrestricted areas should not result in an annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 3 millirems to the total body or 10 millirems to any organ.

B. The calculated annual total quantity of all radioactive material above background that may be released from each light-water-cooled nuclear power reactor to the atmosphere should not result in an annual air dose from gaseous effluents at any location near ground level which could be occupied by individuals in unrestricted areas in excess of 10 millirads for gamma radiation or 20 millirads for beta radiation, or that this quantity should not result in an annual external dose from gaseous effluents to any individual in unrestricted areas in excess of 5 millirems to the total body or 15 millirems to the skin.

C. The calculated annual total quantity of all radioactive iodine and radioactive material in particulate form above background that may be released from each light-water-cooled nuclear power reactor in effluents to the atmosphere should not result in an annual dose or dose commitment from such radioactive iodine and radioactive material in particulate form for any individual in an unrestricted area from all pathways of exposure in excess of 15 millirems to any organ.

D. Pursuant to NRC interpretation as stated in PBNP TS 5.5.4.i, the dose guideline of Section 4.2.C, above, applies only to I-131, I-133, H-3, and all particulate material released to the atmosphere which has a half-life >8 days. Particulates with shorter half-lives are not considered because of their negligible dose contribution.

4.3 Release Limits

Based on the Appendix I dose limits, Point Beach, being a two (2) unit nuclear plant, may release into the environment the quantities of radionuclides above background that fulfill the criteria listed below.

A. Pursuant to Section 4.2.A, the doses from radionuclides in the unrestricted area in liquids shall not exceed

1. Six (6) millirem to the whole body, or

2. Twenty (20) millirem to any organ.

B. Pursuant to Section 4.2.B, the doses from gaseous radionuclides in the unrestricted area shall not exceed

1. Twenty (20) millirads to the air from gamma radiation,

2. Forty (40) millirads to the air from beta radiation,

3. Ten (10) millirem to the whole body, or

4. Thirty (30) millirem to the skin.

C. Pursuant to Section 4.2.C, the dose from radioiodine and radioactive material in particulate form released to the atmosphere in the unrestricted area shall not exceed thirty (30) millirem to any organ.

D. Quarterly release limits are defined as ½ the annual limits.

4.4 EPA Regulations

Compliance with the provisions of Appendix I to 10 CFR 50 is adequate demonstration of conformance to the standards set forth in 40 CFR 190 regarding the dose commitment to individuals from the uranium fuel cycle. For 40 CFR 190 compliance, quarterly dose calculations shall include exposures from effluent pathways and direct radiation contributions from the reactor units and from any outside storage tanks.

The above calculations do not include contributions from the Kewaunee Nuclear Power Plant (KNPP) which is some four miles north of PBNP. Under normal operations using the PBNP annual average χ/Q and assuming that the KNPP source term is identical to either PBNP unit, the greatest KNPP dose contribution occurs at the north sector PBNP boundary. However, the total KNPP-PBNP dose at that point is less than the dose in the highest sector (south boundary) from PBNP alone. The KNPP contribution in this sector adds only 1 percent to 8 percent to the total dose depending upon the release mode. Even in the highly unlikely event that PBNP and KNPP operated for an entire year at twice the Appendix I levels, the small percentage contribution from KNPP would be insufficient to yield doses exceeding 40 CFR 190 limits.

5.0 CALCULATION AND COMPARISON OF EFFLUENT RELEASES TO RELEASE LIMITS

Technical Specification 5.5.4.e requires that an effluent release summary and dose calculations be performed periodically. This section describes the methodology for the calculation of doses for comparison to the corresponding dose limits. For Appendix I compliance, the organ and whole body doses shall be calculated for the maximally exposed individual in each age group using the appropriate total dose factors in mrem/Ci released which were obtained using Regulatory Guide 1.109 and other documented methodologies.

5.1 Appendix I Dose Calculations

5.1.1 Liquid Release Mode

The dose calculations for demonstration of compliance with the 10 CFR 50, Appendix I dose limits will be accomplished by the Radiological Engineering Group. Doses will be calculated for each month to track compliance with effluent and dose goals. The doses from each radionuclide will be calculated for each age group and for each organ, including the whole body, and summed over all the identified radionuclides released. The total dose is compared to the corresponding liquid release mode Appendix I dose limit for the organ in question. Noble gases released in liquids are added to the atmospherically released noble gases for Appendix I dose compliance calculations.

The doses are calculated using the following formula:

$$API = \Sigma\, Dose_{aomi} = \Sigma\, (TDF_{aomi} \times C_i) \leq K_{om}\ \text{mrem}$$

where

API	=	the Appendix I dose for compliance evaluation in mrem
$Dose_{aomi}$	=	the dose to the specific age group (a) and organ (o) via release mode (m) from radionuclide (i)
TDF_{aomi}	=	total dose factor for the specific age group (a) and organ (o) via release mode (m) from radionuclide (i) from Table 5.1-1 in mrem/Ci
C_i	=	curies of radionuclide (i) released
K_{om}	=	the Appendix I dose limit for organ (o) and release mode (m) for which the calculation is being made.

The methodology and the values used to obtain the TDF_{aomi} values are given in Appendix C.

It is recognized that some of the release quantities may not be available at the end of the month because the samples from these release paths are sent to a vendor for analysis. Usually, the only radionuclides affected by these delays are Sr-89 and Sr-90. Because the quantities of these two radionuclides are but a small fraction of the total release, the absence of their dose contributions from the initial monthly dose calculation will not significantly affect the total dose obtained from the remaining radionuclides. The dose for the month will be updated upon the receipt of the vendor isotopic results and upon the receipt of any corrections to previous release quantities.

Note that all of the liquid release dose calculations assume that the discharge rate is 677,000 gpm. Whenever the average discharge rate for the month or year differs, the final dose calculated must be multiplied by the correction factor CF where:

CF = 677,000 gpm / actual average discharge gpm

This correction will produce a greater change during the winter months when the circ water flow rates are lower.

TABLE 5.1-1
LIQUID EFFLUENT DOSE FACTOR

Summation of dose per curie released factor calculations over the pathways: potable water, aquatic food, shoreline deposit, irrigated foods (milk), and irrigated foods (meat).

Dose factor - liquid release pathway (mrem/Ci released)							
H-3							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06	4.46E-06
Teen	0.00E+00	4.04E-06	4.04E-06	4.04E-06	4.04E-06	4.04E-06	4.04E-06
Child	0.00E+00	6.67E-06	6.67E-06	6.67E-06	6.67E-06	6.67E-06	6.67E-06
Infant	0.00E+00	7.79E-06	7.79E-06	7.79E-06	7.79E-06	7.79E-06	7.79E-06

Dose factor - liquid release pathway (mrem/Ci released)							
F-18							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.15E-07	9.12E-89	1.28E-08	0.00E+00	5.14E-89	0.00E+00	3.40E-09
Teen	1.21E-07	7.59E-89	1.35E-08	0.00E+00	4.35E-89	0.00E+00	1.09E-08
Child	1.51E-07	1.08E-88	1.50E-08	0.00E+00	5.74E-89	0.00E+00	4.08E-08
Infant	2.05E-12	0.00E+00	1.75E-13	0.00E+00	0.00E+00	0.00E+00	4.83E-13

Dose factor - liquid release pathway (mrem/Ci released)							
Na-22							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	4.71E-03	4.71E-03	4.82E-03	4.71E-03	4.71E-03	4.71E-03	4.71E-03
Teen	5.48E-03	5.48E-03	6.07E-03	5.48E-03	5.48E-03	5.48E-03	5.48E-03
Child	8.32E-03	8.32E-03	8.45E-03	8.32E-03	8.32E-03	8.32E-03	8.32E-03
Infant	7.21E-03	7.21E-03	7.21E-03	7.21E-03	7.21E-03	7.21E-03	7.21E-03

Dose factor - liquid release pathway (mrem/Ci released)							
Na-24							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.85E-04	1.85E-04	1.85E-04	1.85E-04	1.85E-04	1.85E-04	1.85E-04
Teen	1.98E-04	1.98E-04	1.98E-04	1.98E-04	1.98E-04	1.98E-04	1.98E-04
Child	2.40E-04	2.40E-04	2.40E-04	2.40E-04	2.40E-04	2.40E-04	2.40E-04
Infant	8.06E-05	8.06E-05	8.06E-05	8.06E-05	8.06E-05	8.06E-05	8.06E-05

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Sc-46							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.70E-07	3.31E-07	8.92E-06	0.00E+00	3.09E-07	0.00E+00	1.61E-03
Teen	1.52E-07	2.97E-07	4.94E-05	0.00E+00	2.84E-07	0.00E+00	1.01E-03
Child	3.54E-07	4.85E-07	1.05E-05	0.00E+00	4.29E-07	0.00E+00	7.09E-04
Infant	3.42E-07	4.94E-07	1.54E-07	0.00E+00	3.25E-07	0.00E+00	3.22E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Mn-54							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	3.28E-03	6.34E-04	0.00E+00	9.75E-04	0.00E+00	1.00E-02
Teen	0.00E+00	3.22E-03	6.86E-04	0.00E+00	9.59E-04	0.00E+00	6.60E-03
Child	0.00E+00	2.60E-03	7.04E-04	0.00E+00	7.30E-04	0.00E+00	2.19E-03
Infant	0.00E+00	1.92E-04	4.34E-05	0.00E+00	4.25E-05	0.00E+00	7.04E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Cr-51							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	0.00E+00	1.01E-06	5.84E-07	2.15E-07	1.30E-06	2.46E-04
Teen	0.00E+00	0.00E+00	1.17E-06	5.60E-07	2.21E-07	1.44E-06	1.70E-04
Child	0.00E+00	0.00E+00	1.19E-06	6.44E-07	1.76E-07	1.18E-06	6.15E-05
Infant	0.00E+00	0.00E+00	1.72E-07	1.12E-07	2.45E-08	2.18E-07	5.01E-06

Dose factor - liquid release pathway (mrem/Ci released)							
Mn-56							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	3.18E-06	5.65E-07	0.00E+00	4.04E-06	0.00E+00	1.02E-04
Teen	0.00E+00	3.33E-06	5.94E-07	0.00E+00	4.22E-06	0.00E+00	2.19E-04
Child	0.00E+00	3.04E-06	6.86E-07	0.00E+00	3.67E-06	0.00E+00	4.40E-04
Infant	0.00E+00	1.97E-11	3.39E-12	0.00E+00	1.69E-11	0.00E+00	1.79E-09

Dose factor - liquid release pathway (mrem/Ci released)							
Fe-55							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.98E-04	4.13E-04	9.63E-05	0.00E+00	0.00E+00	2.31E-04	2.37E-04
Teen	6.11E-04	4.33E-04	1.01E-04	0.00E+00	0.00E+00	2.75E-04	1.88E-04
Child	9.35E-04	4.96E-04	1.54E-04	0.00E+00	0.00E+00	2.80E-04	9.19E-05
Infant	1.55E-04	1.00E-04	2.68E-05	0.00E+00	0.00E+00	4.91E-05	1.28E-05

OFFSITE DOSE CALCULATION MANUAL

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Fe-59							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	9.12E-04	2.14E-03	8.23E-04	0.00E+00	0.00E+00	5.99E-04	7.14E-03
Teen	9.22E-04	2.15E-03	8.40E-04	0.00E+00	0.00E+00	6.79E-04	5.09E-03
Child	1.29E-03	2.09E-03	1.04E-03	0.00E+00	0.00E+00	6.07E-04	2.18E-03
Infant	3.34E-04	5.84E-04	2.30E-04	0.00E+00	0.00E+00	1.73E-04	2.79E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Co-57							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	2.02E-05	3.57E-05	0.00E+00	0.00E+00	0.00E+00	5.13E-04
Teen	0.00E+00	2.06E-05	4.62E-05	0.00E+00	0.00E+00	0.00E+00	3.83E-04
Child	0.00E+00	2.31E-05	4.93E-05	0.00E+00	0.00E+00	0.00E+00	1.89E-04
Infant	0.00E+00	1.24E-05	2.02E-05	0.00E+00	0.00E+00	0.00E+00	4.24E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Co-58							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	8.49E-05	1.93E-04	0.00E+00	0.00E+00	0.00E+00	1.72E-03
Teen	0.00E+00	8.30E-05	2.04E-04	0.00E+00	0.00E+00	0.00E+00	1.14E-03
Child	0.00E+00	8.32E-05	2.57E-04	0.00E+00	0.00E+00	0.00E+00	4.85E-04
Infant	0.00E+00	3.84E-05	9.58E-05	0.00E+00	0.00E+00	0.00E+00	9.57E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Co-60							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	2.48E-04	6.82E-04	0.00E+00	0.00E+00	0.00E+00	4.66E-03
Teen	0.00E+00	2.44E-04	1.30E-03	0.00E+00	0.00E+00	0.00E+00	3.17E-03
Child	0.00E+00	2.49E-04	8.92E-04	0.00E+00	0.00E+00	0.00E+00	1.38E-03
Infant	0.00E+00	1.17E-04	2.77E-04	0.00E+00	0.00E+00	0.00E+00	2.79E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Ni-63							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.03E-02	2.10E-03	1.02E-03	0.00E+00	0.00E+00	0.00E+00	4.38E-04
Teen	3.13E-02	2.21E-03	1.06E-03	0.00E+00	0.00E+00	0.00E+00	3.52E-04
Child	5.00E-02	2.67E-03	1.70E-03	0.00E+00	0.00E+00	0.00E+00	1.80E-04
Infant	1.27E-02	7.85E-04	4.41E-04	0.00E+00	0.00E+00	0.00E+00	3.91E-05

OFFSITE DOSE CALCULATION MANUAL

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Ni-65							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.39E-06	4.40E-07	2.01E-07	0.00E+00	0.00E+00	0.00E+00	1.12E-05
Teen	3.66E-06	4.68E-07	2.13E-07	0.00E+00	0.00E+00	0.00E+00	2.54E-05
Child	4.68E-06	4.41E-07	2.57E-07	0.00E+00	0.00E+00	0.00E+00	5.40E-05
Infant	1.74E-10	1.97E-11	8.95E-12	0.00E+00	0.00E+00	0.00E+00	1.50E-09

Dose factor - liquid release pathway (mrem/Ci released)							
Cu-64							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	4.02E-06	1.89E-06	0.00E+00	1.01E-05	0.00E+00	3.43E-04
Teen	0.00E+00	4.31E-06	2.04E-06	0.00E+00	1.09E-05	0.00E+00	3.34E-04
Child	0.00E+00	4.30E-06	2.60E-06	0.00E+00	1.04E-05	0.00E+00	2.02E-04
Infant	0.00E+00	1.41E-06	6.52E-07	0.00E+00	2.38E-06	0.00E+00	2.89E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Zn-65							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.73E-02	5.50E-02	2.49E-02	0.00E+00	3.68E-02	0.00E+00	3.46E-02
Teen	1.58E-02	5.50E-02	2.57E-02	0.00E+00	3.52E-02	0.00E+00	2.33E-02
Child	1.68E-02	4.47E-02	2.78E-02	0.00E+00	2.82E-02	0.00E+00	7.85E-03
Infant	1.32E-03	4.51E-03	2.08E-03	0.00E+00	2.19E-03	0.00E+00	3.81E-03

Dose factor - liquid release pathway (mrem/Ci released)							
Zn-69							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.97E-05	3.76E-05	2.62E-06	0.00E+00	2.44E-05	0.00E+00	5.65E-06
Teen	2.14E-05	4.08E-05	2.86E-06	0.00E+00	2.67E-05	0.00E+00	7.52E-05
Child	2.77E-05	4.00E-05	3.70E-06	0.00E+00	2.43E-05	0.00E+00	2.52E-03
Infant	5.98E-07	1.08E-06	8.01E-08	0.00E+00	4.47E-07	0.00E+00	8.78E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Zn-69m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.25E-04	7.79E-04	7.12E-05	0.00E+00	4.72E-04	0.00E+00	4.76E-02
Teen	3.50E-04	8.25E-04	7.57E-05	0.00E+00	5.01E-04	0.00E+00	4.53E-02
Child	4.49E-04	7.65E-04	9.04E-05	0.00E+00	4.44E-04	0.00E+00	2.49E-02
Infant	9.61E-06	1.96E-05	1.79E-06	0.00E+00	7.94E-06	0.00E+00	2.72E-04

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Br-82							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	0.00E+00	1.39E-03	0.00E+00	0.00E+00	0.00E+00	1.59E-03
Teen	0.00E+00	0.00E+00	1.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Child	0.00E+00	0.00E+00	1.71E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Infant	0.00E+00	0.00E+00	4.43E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Dose factor - liquid release pathway (mrem/Ci released)							
Br-83							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	0.00E+00	9.06E-07	0.00E+00	0.00E+00	0.00E+00	1.30E-06
Teen	0.00E+00	0.00E+00	9.85E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Child	0.00E+00	0.00E+00	1.27E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Infant	0.00E+00	0.00E+00	2.93E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Dose factor - liquid release pathway (mrem/Ci released)							
Br-84							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	0.00E+00	3.12E-05	0.00E+00	0.00E+00	0.00E+00	2.44E-10
Teen	0.00E+00	0.00E+00	3.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Child	0.00E+00	0.00E+00	4.33E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Infant	0.00E+00	0.00E+00	1.20E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Dose factor - liquid release pathway (mrem/Ci released)							
Br-85							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	0.00E+00	4.24E-82	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Teen	0.00E+00	0.00E+00	4.60E-82	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Child	0.00E+00	0.00E+00	5.94E-82	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Infant	0.00E+00	0.00E+00	9.35E-309	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Dose factor - liquid release pathway (mrem/Ci released)							
Rb-86							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	7.36E-02	3.43E-02	0.00E+00	0.00E+00	0.00E+00	1.45E-02
Teen	0.00E+00	7.98E-02	3.75E-02	0.00E+00	0.00E+00	0.00E+00	1.18E-02
Child	0.00E+00	7.93E-02	4.88E-02	0.00E+00	0.00E+00	0.00E+00	5.10E-03
Infant	0.00E+00	9.07E-03	4.48E-03	0.00E+00	0.00E+00	0.00E+00	2.32E-04

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Rb-88							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	1.41E-16	7.46E-17	0.00E+00	0.00E+00	0.00E+00	1.94E-27
Teen	0.00E+00	1.51E-16	8.04E-17	0.00E+00	0.00E+00	0.00E+00	1.29E-23
Child	0.00E+00	1.45E-16	1.01E-16	0.00E+00	0.00E+00	0.00E+00	7.12E-18
Infant	0.00E+00	5.68E-54	3.12E-54	0.00E+00	0.00E+00	0.00E+00	5.54E-54

Dose factor - liquid release pathway (mrem/Ci released)							
Rb-89							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	1.28E-18	8.99E-19	0.00E+00	0.00E+00	0.00E+00	7.42E-32
Teen	0.00E+00	1.34E-18	9.45E-19	0.00E+00	0.00E+00	0.00E+00	2.05E-27
Child	0.00E+00	1.23E-18	1.09E-18	0.00E+00	0.00E+00	0.00E+00	1.07E-20
Infant	0.00E+00	1.15E-61	7.93E-62	0.00E+00	0.00E+00	0.00E+00	3.92E-62

Dose factor - liquid release pathway (mrem/Ci released)							
Sr-89							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.26E-02	0.00E+00	6.48E-04	0.00E+00	0.00E+00	0.00E+00	3.62E-03
Teen	2.43E-02	0.00E+00	6.95E-04	0.00E+00	0.00E+00	0.00E+00	2.89E-03
Child	4.27E-02	0.00E+00	1.22E-03	0.00E+00	0.00E+00	0.00E+00	1.65E-03
Infant	2.58E-02	0.00E+00	7.40E-04	0.00E+00	0.00E+00	0.00E+00	5.30E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Sr-90							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.63E-01	0.00E+00	1.38E-01	0.00E+00	0.00E+00	0.00E+00	1.63E-02
Teen	4.64E-01	0.00E+00	1.15E-01	0.00E+00	0.00E+00	0.00E+00	1.30E-02
Child	5.59E-01	0.00E+00	1.42E-01	0.00E+00	0.00E+00	0.00E+00	7.53E-03
Infant	1.95E-01	0.00E+00	4.97E-02	0.00E+00	0.00E+00	0.00E+00	2.44E-03

Dose factor - liquid release pathway (mrem/Ci released)							
Sr-91							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.27E-04	0.00E+00	5.14E-06	0.00E+00	0.00E+00	0.00E+00	6.05E-04
Teen	1.38E-04	0.00E+00	5.51E-06	0.00E+00	0.00E+00	0.00E+00	6.24E-04
Child	1.83E-04	0.00E+00	6.91E-06	0.00E+00	0.00E+00	0.00E+00	4.04E-04
Infant	1.59E-05	0.00E+00	5.76E-07	0.00E+00	0.00E+00	0.00E+00	1.88E-05

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Sr-92							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.21E-06	0.00E+00	2.26E-07	0.00E+00	0.00E+00	0.00E+00	1.03E-04
Teen	5.64E-06	0.00E+00	2.42E-07	0.00E+00	0.00E+00	0.00E+00	1.44E-04
Child	7.20E-06	0.00E+00	2.89E-07	0.00E+00	0.00E+00	0.00E+00	1.36E-04
Infant	9.41E-10	0.00E+00	3.50E-11	0.00E+00	0.00E+00	0.00E+00	1.01E-08

Dose factor - liquid release pathway (mrem/Ci released)							
Y-90							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	4.85E-07	0.00E+00	1.30E-08	0.00E+00	0.00E+00	0.00E+00	5.15E-03
Teen	5.16E-07	0.00E+00	1.40E-08	0.00E+00	0.00E+00	0.00E+00	4.26E-03
Child	8.67E-07	0.00E+00	2.32E-08	0.00E+00	0.00E+00	0.00E+00	2.47E-03
Infant	4.80E-07	0.00E+00	1.29E-08	0.00E+00	0.00E+00	0.00E+00	6.63E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Y-91							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	9.20E-06	0.00E+00	2.53E-07	0.00E+00	0.00E+00	0.00E+00	5.06E-03
Teen	9.68E-06	0.00E+00	2.97E-07	0.00E+00	0.00E+00	0.00E+00	3.97E-03
Child	1.74E-05	0.00E+00	4.74E-07	0.00E+00	0.00E+00	0.00E+00	2.32E-03
Infant	1.03E-05	0.00E+00	2.73E-07	0.00E+00	0.00E+00	0.00E+00	7.35E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Y-91m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.71E-13	0.00E+00	5.10E-14	0.00E+00	0.00E+00	0.00E+00	5.02E-13
Teen	1.85E-13	0.00E+00	2.55E-13	0.00E+00	0.00E+00	0.00E+00	8.72E-12
Child	2.36E-13	0.00E+00	6.04E-14	0.00E+00	0.00E+00	0.00E+00	4.62E-10
Infant	2.62E-26	0.00E+00	8.92E-28	0.00E+00	0.00E+00	0.00E+00	8.72E-23

Dose factor - liquid release pathway (mrem/Ci released)							
Y-92							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.51E-09	0.00E+00	2.88E-10	0.00E+00	0.00E+00	0.00E+00	6.15E-05
Teen	3.83E-09	0.00E+00	1.15E-09	0.00E+00	0.00E+00	0.00E+00	1.05E-04
Child	4.92E-09	0.00E+00	3.57E-10	0.00E+00	0.00E+00	0.00E+00	1.42E-04
Infant	5.88E-12	0.00E+00	1.65E-13	0.00E+00	0.00E+00	0.00E+00	1.12E-07

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Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Y-93							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.32E-08	0.00E+00	2.33E-09	0.00E+00	0.00E+00	0.00E+00	1.69E-03
Teen	5.77E-08	0.00E+00	6.38E-09	0.00E+00	0.00E+00	0.00E+00	1.76E-03
Child	7.75E-08	0.00E+00	3.13E-09	0.00E+00	0.00E+00	0.00E+00	1.16E-03
Infant	8.33E-09	0.00E+00	2.27E-10	0.00E+00	0.00E+00	0.00E+00	6.58E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Zr-95							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.23E-06	3.94E-07	1.79E-06	0.00E+00	6.19E-07	0.00E+00	1.25E-03
Teen	1.11E-06	3.52E-07	8.74E-06	0.00E+00	5.17E-07	0.00E+00	8.11E-04
Child	2.48E-06	5.45E-07	2.26E-06	0.00E+00	7.80E-07	0.00E+00	5.69E-04
Infant	1.87E-06	4.56E-07	3.23E-07	0.00E+00	4.91E-07	0.00E+00	2.27E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Zr-97							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.07E-08	2.16E-09	1.23E-08	0.00E+00	3.27E-09	0.00E+00	6.70E-04
Teen	1.11E-08	2.19E-09	6.42E-08	0.00E+00	3.33E-09	0.00E+00	5.94E-04
Child	2.21E-08	3.19E-09	1.51E-08	0.00E+00	4.58E-09	0.00E+00	4.83E-04
Infant	1.92E-08	3.29E-09	1.50E-09	0.00E+00	3.32E-09	0.00E+00	2.10E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Nb-95							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.23E-04	1.79E-04	9.73E-05	0.00E+00	1.77E-04	0.00E+00	1.09E+00
Teen	3.25E-04	1.80E-04	1.04E-04	0.00E+00	1.75E-04	0.00E+00	7.70E-01
Child	3.84E-04	1.49E-04	1.08E-04	0.00E+00	1.40E-04	0.00E+00	2.76E-01
Infant	5.36E-07	2.21E-07	1.28E-07	0.00E+00	1.58E-07	0.00E+00	1.86E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Nb-97							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.69E-09	6.81E-10	2.51E-10	0.00E+00	7.95E-10	0.00E+00	2.51E-06
Teen	2.90E-09	7.20E-10	2.73E-10	0.00E+00	8.41E-10	0.00E+00	1.72E-05
Child	3.68E-09	6.65E-10	3.12E-10	0.00E+00	7.38E-10	0.00E+00	2.05E-04
Infant	5.81E-21	1.24E-10	4.47E-22	0.00E+00	9.68E-22	0.00E+00	3.91E-16

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Mo-99							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	0.00E+00	1.49E-04	2.84E-05	0.00E+00	3.38E-04	0.00E+00	3.46E-04
Teen	0.00E+00	1.76E-04	3.36E-05	0.00E+00	4.03E-04	0.00E+00	3.15E-04
Child	0.00E+00	2.79E-04	6.91E-05	0.00E+00	5.96E-04	0.00E+00	2.31E-04
Infant	0.00E+00	4.38E-04	8.54E-05	0.00E+00	6.54E-04	0.00E+00	1.44E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Tc-99m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.68E-09	4.74E-09	6.07E-08	0.00E+00	7.20E-08	2.32E-09	2.81E-06
Teen	1.74E-09	4.86E-09	6.46E-08	0.00E+00	7.24E-08	2.70E-09	3.19E-06
Child	2.19E-09	4.29E-09	7.15E-08	0.00E+00	6.24E-08	2.18E-09	2.44E-06
Infant	3.78E-10	7.79E-10	1.00E-08	0.00E+00	8.38E-09	4.07E-10	2.26E-07

Dose factor - liquid release pathway (mrem/Ci released)							
Tc-101							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.60E-24	5.19E-24	5.10E-23	0.00E+00	9.34E-23	2.65E-24	1.56E-35
Teen	3.89E-24	5.53E-24	5.49E-23	0.00E+00	1.00E-22	3.37E-24	9.45E-31
Child	4.98E-24	5.22E-24	6.63E-23	0.00E+00	8.90E-23	2.76E-24	1.66E-23
Infant	9.73E-69	1.23E-68	1.21E-67	0.00E+00	1.46E-67	6.69E-69	2.08E-66

Dose factor - liquid release pathway (mrem/Ci released)							
Ru-103							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.47E-05	0.00E+00	1.56E-05	0.00E+00	1.32E-04	0.00E+00	4.05E-03
Teen	2.96E-05	0.00E+00	1.64E-05	0.00E+00	1.04E-04	0.00E+00	2.47E-03
Child	5.53E-05	0.00E+00	2.20E-05	0.00E+00	1.39E-04	0.00E+00	1.43E-03
Infant	1.33E-05	0.00E+00	4.43E-06	0.00E+00	2.76E-05	0.00E+00	1.61E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Ru-105							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	4.13E-08	0.00E+00	1.75E-08	0.00E+00	5.34E-07	0.00E+00	2.53E-05
Teen	4.45E-08	0.00E+00	2.42E-08	0.00E+00	5.62E-07	0.00E+00	3.59E-05
Child	5.71E-08	0.00E+00	2.22E-08	0.00E+00	5.02E-07	0.00E+00	3.73E-05
Infant	6.98E-10	0.00E+00	2.35E-10	0.00E+00	5.13E-09	0.00E+00	2.78E-07

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Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Ru-106							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	6.71E-04	0.00E+00	8.76E-05	0.00E+00	1.30E-03	0.00E+00	4.34E-02
Teen	5.86E-04	0.00E+00	8.85E-05	0.00E+00	1.13E-03	0.00E+00	2.81E-02
Child	1.13E-03	0.00E+00	1.44E-04	0.00E+00	1.53E-03	0.00E+00	1.76E-02
Infant	2.23E-04	0.00E+00	2.78E-05	0.00E+00	2.63E-04	0.00E+00	1.69E-03

Dose factor - liquid release pathway (mrem/Ci released)							
Rh-105							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.35E-06	2.45E-06	1.62E-06	0.00E+00	1.04E-05	0.00E+00	3.90E-04
Teen	4.10E-06	2.96E-06	1.97E-06	0.00E+00	1.26E-05	0.00E+00	3.77E-04
Child	8.43E-06	4.52E-06	3.88E-06	0.00E+00	1.80E-05	0.00E+00	2.80E-04
Infant	1.08E-05	7.05E-06	4.74E-06	0.00E+00	1.96E-05	0.00E+00	1.75E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Ag-110m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.06E-05	2.83E-05	3.83E-05	0.00E+00	5.56E-05	0.00E+00	1.15E-02
Teen	3.74E-05	3.54E-05	1.41E-04	0.00E+00	6.75E-05	0.00E+00	9.94E-03
Child	6.78E-05	4.58E-05	6.17E-05	0.00E+00	8.53E-05	0.00E+00	5.45E-03
Infant	8.87E-05	6.47E-05	4.28E-05	0.00E+00	9.26E-05	0.00E+00	3.36E-03

Sn-113 and Sn-117m - liquid release pathway (mrem/Ci released)							
	Bone	Liver	W. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	6.40E-03	2.17E-04	6.78E-04	1.26E-04	0.00E+00	0.00E+00	1.32E-01
Teen	6.96E-03	2.33E-04	7.33E-04	1.28E-04	0.00E+00	0.00E+00	1.08E-01
Child	9.03E-03	2.28E-04	9.44E-04	1.66E-04	0.00E+00	0.00E+00	4.61E-02
Infant	1.42E-04	4.43E-06	1.47E-05	3.07E-06	0.00E+00	0.00E+00	3.50E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Sb-124							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.42E-04	1.02E-05	2.21E-04	1.32E-06	0.00E+00	4.22E-04	1.54E-02
Teen	5.66E-04	1.04E-05	2.53E-04	1.28E-06	0.00E+00	4.94E-04	1.14E-02
Child	7.89E-04	1.02E-05	2.83E-04	1.74E-06	0.00E+00	4.38E-04	4.94E-03
Infant	1.95E-04	2.86E-06	6.03E-05	5.17E-07	0.00E+00	1.22E-04	6.00E-04

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Sb-125							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.49E-04	3.90E-06	1.07E-04	3.55E-07	0.00E+00	2.69E-04	3.85E-03
Teen	3.65E-04	3.99E-06	2.19E-04	3.49E-07	0.00E+00	3.21E-04	2.84E-03
Child	5.14E-04	3.96E-06	1.35E-04	4.76E-07	0.00E+00	2.86E-04	1.23E-03
Infant	1.14E-04	1.11E-06	2.35E-05	1.43E-07	0.00E+00	7.17E-05	1.52E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Te-125m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.30E-04	1.20E-04	4.43E-05	9.93E-05	1.34E-03	0.00E+00	1.32E-03
Teen	3.36E-04	1.21E-04	4.53E-05	9.39E-05	0.00E+00	0.00E+00	9.92E-04
Child	5.74E-04	1.56E-04	7.67E-05	1.61E-04	0.00E+00	0.00E+00	5.54E-04
Infant	2.47E-04	8.27E-05	3.35E-05	8.33E-05	0.00E+00	0.00E+00	1.18E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Te-127							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.15E-05	1.13E-05	6.83E-06	2.34E-05	1.28E-04	0.00E+00	2.49E-03
Teen	3.45E-05	1.22E-05	7.43E-06	2.38E-05	1.40E-04	0.00E+00	2.67E-03
Child	4.45E-05	1.20E-05	9.54E-06	3.08E-05	1.27E-04	0.00E+00	1.74E-03
Infant	3.10E-07	1.04E-07	6.67E-08	2.52E-07	7.56E-07	0.00E+00	6.51E-06

Dose factor - liquid release pathway (mrem/Ci released)							
Te-127m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	8.63E-04	3.08E-04	1.05E-04	2.21E-04	3.51E-03	0.00E+00	2.89E-03
Teen	8.74E-04	3.10E-04	1.04E-04	2.08E-04	3.54E-03	0.00E+00	2.18E-03
Child	1.50E-03	4.05E-04	1.79E-04	3.60E-04	4.29E-03	0.00E+00	1.22E-03
Infant	6.28E-04	2.08E-04	7.61E-05	1.82E-04	1.55E-03	0.00E+00	2.54E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Te-129							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.68E-08	6.32E-09	4.10E-09	1.29E-08	7.07E-08	0.00E+00	1.27E-08
Teen	1.83E-08	6.82E-09	4.45E-09	1.31E-08	7.68E-08	0.00E+00	1.00E-07
Child	2.36E-08	6.58E-09	5.60E-09	1.68E-08	6.90E-08	0.00E+00	1.47E-06
Infant	1.08E-18	3.73E-19	2.53E-19	9.07E-19	2.69E-18	0.00E+00	8.65E-17

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Te-129m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.35E-03	5.04E-04	2.14E-04	4.64E-04	5.63E-03	0.00E+00	6.80E-03
Teen	1.37E-03	5.10E-04	2.18E-04	4.43E-04	5.75E-03	0.00E+00	5.16E-03
Child	2.34E-03	6.54E-04	3.64E-04	7.55E-04	6.88E-03	0.00E+00	2.86E-03
Infant	1.04E-03	3.58E-04	1.61E-04	4.01E-04	2.61E-03	0.00E+00	6.23E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Te-131m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.04E-04	5.08E-05	4.24E-05	8.05E-05	5.15E-04	0.00E+00	5.05E-03
Teen	1.11E-04	5.34E-05	4.49E-05	8.03E-05	5.56E-04	0.00E+00	4.28E-03
Child	1.63E-04	5.63E-05	6.00E-05	1.16E-04	5.45E-04	0.00E+00	2.28E-03
Infant	5.46E-05	2.20E-05	1.81E-05	4.45E-05	1.51E-04	0.00E+00	3.70E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Te-131							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.97E-15	1.24E-15	9.40E-16	2.44E-15	1.30E-14	0.00E+00	4.21E-16
Teen	3.21E-15	1.32E-15	1.01E-15	2.47E-15	1.40E-14	0.00E+00	2.63E-16
Child	4.12E-15	1.25E-15	1.23E-15	3.15E-15	1.24E-14	0.00E+00	2.16E-14
Infant	4.22E-41	1.56E-41	1.18E-41	3.77E-41	1.08E-40	0.00E+00	1.71E-39

Dose factor - liquid release pathway (mrem/Ci released)							
Te-132							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.96E-04	1.26E-04	1.19E-04	1.40E-04	1.22E-03	0.00E+00	5.98E-03
Teen	2.05E-04	1.30E-04	1.22E-04	1.37E-04	1.24E-03	0.00E+00	4.11E-03
Child	3.15E-04	1.39E-04	1.69E-04	2.03E-04	1.29E-03	0.00E+00	1.40E-03
Infant	1.48E-04	7.32E-05	6.83E-05	1.08E-04	4.58E-04	0.00E+00	2.71E-04

Dose factor - liquid release pathway (mrem/Ci released)							
I-131							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.09E-04	2.99E-04	1.71E-04	9.78E-02	5.12E-04	0.00E+00	7.88E-05
Teen	2.41E-04	3.37E-04	1.81E-04	9.83E-02	5.80E-04	0.00E+00	6.66E-05
Child	4.90E-04	4.93E-04	2.80E-04	1.63E-01	8.09E-04	0.00E+00	4.39E-05
Infant	5.71E-04	6.73E-04	2.96E-04	2.21E-01	7.86E-04	0.00E+00	2.40E-05

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
I-132							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.43E-07	3.81E-07	1.34E-07	1.33E-05	6.07E-07	0.00E+00	7.16E-08
Teen	1.49E-07	3.90E-07	1.41E-07	1.32E-05	6.15E-07	0.00E+00	1.70E-07
Child	1.85E-07	3.39E-07	1.56E-07	1.57E-05	5.19E-07	0.00E+00	3.99E-07
Infant	1.64E-11	3.32E-11	1.18E-11	1.56E-09	3.71E-11	0.00E+00	2.69E-11

Dose factor - liquid release pathway (mrem/Ci released)							
I-133							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.33E-05	5.80E-05	1.77E-05	8.52E-03	1.01E-04	0.00E+00	5.21E-05
Teen	3.74E-05	6.34E-05	1.94E-05	8.85E-03	1.11E-04	0.00E+00	4.80E-05
Child	6.27E-05	7.75E-05	2.94E-05	1.44E-02	1.29E-04	0.00E+00	3.13E-05
Infant	4.77E-05	6.95E-05	2.04E-05	1.26E-02	8.17E-05	0.00E+00	1.18E-05

Dose factor - liquid release pathway (mrem/Ci released)							
I-134							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.09E-10	5.69E-10	2.04E-10	9.85E-09	9.04E-10	0.00E+00	4.96E-13
Teen	2.20E-10	5.82E-10	2.10E-10	9.70E-09	9.18E-10	0.00E+00	7.67E-12
Child	2.72E-10	5.05E-10	2.33E-10	1.16E-08	7.72E-10	0.00E+00	3.35E-10
Infant	5.37E-22	1.10E-21	3.91E-22	2.56E-20	1.23E-21	0.00E+00	1.14E-21

Dose factor - liquid release pathway (mrem/Ci released)							
I-135							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.37E-06	8.83E-06	3.26E-06	5.82E-04	1.42E-05	0.00E+00	9.97E-06
Teen	3.55E-06	9.14E-06	3.41E-06	5.88E-04	1.44E-05	0.00E+00	1.01E-05
Child	4.54E-06	8.17E-06	3.87E-06	7.24E-04	1.25E-05	0.00E+00	6.23E-06
Infant	4.48E-07	8.92E-07	3.25E-07	7.99E-05	9.94E-07	0.00E+00	3.23E-07

Dose factor - liquid release pathway (mrem/Ci released)							
Cs-134							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.19E-01	5.21E-01	4.26E-01	0.00E+00	1.69E-01	5.60E-02	9.12E-03
Teen	2.25E-01	5.30E-01	2.46E-01	0.00E+00	1.68E-01	6.43E-02	6.59E-03
Child	2.76E-01	4.52E-01	9.55E-02	0.00E+00	1.40E-01	5.03E-02	2.44E-03
Infant	1.07E-02	2.00E-02	2.02E-03	0.00E+00	5.16E-03	2.11E-03	5.44E-05

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Cs-134m							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	4.21E-06	8.85E-06	4.52E-06	0.00E+00	4.80E-06	7.56E-07	3.12E-06
Teen	4.42E-06	9.16E-06	4.71E-06	0.00E+00	5.10E-06	8.95E-07	6.0E-06
Child	5.48E-06	8.11E-06	5.29E-06	0.00E+00	4.28E-06	7.07E-07	1.03E-05
Infant	5.19E-11	8.64E-11	4.37E-11	0.00E+00	3.33E-11	7.67E-12	6.84E-11

Dose factor - liquid release pathway (mrem/Ci released)							
Cs-136							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.23E-02	8.81E-02	6.34E-02	0.00E+00	4.90E-02	6.72E-03	1.00E-02
Teen	2.25E-02	8.85E-02	5.95E-02	0.00E+00	4.82E-02	7.59E-03	7.12E-03
Child	2.69E-02	7.40E-02	4.79E-02	0.00E+00	3.94E-02	5.87E-03	2.60E-03
Infant	1.18E-03	3.47E-03	1.29E-03	0.00E+00	1.38E-03	2.83E-04	5.27E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Cs-137							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.81E-01	3.84E-01	2.52E-01	0.00E+00	1.30E-01	4.33E-02	7.43E-03
Teen	3.02E-01	4.01E-01	1.40E-01	0.00E+00	1.36E-01	5.30E-02	5.71E-03
Child	3.85E-01	3.69E-01	5.45E-02	0.00E+00	1.20E-01	4.33E-02	2.31E-03
Infant	1.49E-02	1.74E-02	1.24E-03	0.00E+00	4.68E-03	1.89E-03	5.45E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Cs-138							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.57E-11	7.04E-11	3.49E-11	0.00E+00	5.18E-11	5.11E-12	3.00E-16
Teen	3.82E-11	7.34E-11	3.67E-11	0.00E+00	5.42E-11	6.30E-12	3.33E-14
Child	4.84E-11	6.73E-11	4.27E-11	0.00E+00	4.73E-11	5.10E-12	3.10E-11
Infant	1.63E-32	2.65E-32	1.28E-32	0.00E+00	1.32E-32	2.06E-33	4.23E-32

Dose factor - liquid release pathway (mrem/Ci released)							
Ba-139							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.67E-09	1.19E-12	4.93E-11	0.00E+00	1.12E-12	6.77E-13	2.97E-09
Teen	1.83E-09	1.29E-12	5.50E-11	0.00E+00	1.21E-12	8.87E-13	1.63E-08
Child	2.35E-09	1.25E-12	6.84E-11	0.00E+00	1.09E-12	7.37E-13	1.36E-07
Infant	3.30E-16	2.19E-19	9.55E-18	0.00E+00	1.31E-19	1.33E-19	2.09E-14

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Ba-140							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.34E-04	6.71E-07	3.51E-05	0.00E+00	2.28E-07	3.84E-07	1.10E-03
Teen	5.41E-04	6.63E-07	3.56E-05	0.00E+00	2.25E-07	4.46E-07	8.35E-04
Child	1.32E-03	1.16E-06	7.72E-05	0.00E+00	3.76E-07	6.89E-07	6.69E-04
Infant	1.52E-03	1.52E-06	7.84E-05	0.00E+00	3.61E-07	9.34E-07	3.74E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Ba-141							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	4.57E-19	3.45E-22	1.63E-20	0.00E+00	3.21E-22	1.96E-22	2.15E-28
Teen	4.96E-19	3.70E-22	2.14E-20	0.00E+00	3.44E-22	2.53E-22	1.06E-24
Child	6.37E-19	3.57E-22	2.18E-20	0.00E+00	3.09E-22	2.10E-21	3.63E-19
Infant	1.58E-53	1.08E-56	4.99E-55	0.00E+00	6.52E-57	6.60E-57	1.93E-52

Dose factor - liquid release pathway (mrem/Ci released)							
La-140							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.66E-08	1.84E-08	1.03E-07	0.00E+00	0.00E+00	0.00E+00	1.35E-03
Teen	3.68E-08	1.81E-08	5.51E-07	0.00E+00	0.00E+00	0.00E+00	1.04E-03
Child	8.21E-08	2.87E-08	1.24E-07	0.00E+00	0.00E+00	0.00E+00	8.00E-04
Infant	8.56E-08	3.38E-08	8.69E-09	0.00E+00	0.00E+00	0.00E+00	3.97E-04

Dose factor - liquid release pathway (mrem/Ci released)							
La-142							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.92E-11	1.33E-11	4.94E-11	0.00E+00	0.00E+00	0.00E+00	9.71E-08
Teen	3.12E-11	1.38E-11	2.61E-10	0.00E+00	0.00E+00	0.00E+00	4.21E-07
Child	3.93E-11	1.25E-11	5.77E-11	0.00E+00	0.00E+00	0.00E+00	2.48E-06
Infant	7.74E-18	2.84E-18	6.81E-19	0.00E+00	0.00E+00	0.00E+00	4.83E-13

Dose factor - liquid release pathway (mrem/Ci released)							
Ce-141							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.05E-07	1.39E-07	2.42E-07	0.00E+00	6.45E-08	0.00E+00	5.31E-04
Teen	2.06E-07	1.37E-07	4.88E-07	0.00E+00	6.47E-08	0.00E+00	3.93E-04
Child	5.80E-07	2.89E-07	1.42E-07	0.00E+00	1.27E-07	0.00E+00	3.61E-04
Infant	7.11E-07	4.34E-07	5.11E-08	0.00E+00	1.34E-07	0.00E+00	2.24E-04

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Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Ce-143							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.47E-08	1.09E-05	1.78E-08	0.00E+00	4.78E-09	0.00E+00	4.06E-04
Teen	1.49E-08	1.08E-05	9.40E-08	0.00E+00	4.86E-09	0.00E+00	3.26E-04
Child	4.01E-08	2.17E-05	2.25E-08	0.00E+00	9.12E-09	0.00E+00	3.18E-04
Infant	5.10E-08	3.38E-05	3.86E-09	0.00E+00	9.85E-09	0.00E+00	1.97E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Ce-144							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.12E-05	4.67E-06	1.04E-06	0.00E+00	2.77E-06	0.00E+00	3.78E-03
Teen	1.12E-05	4.65E-06	3.03E-06	0.00E+00	2.78E-06	0.00E+00	2.82E-03
Child	3.17E-05	9.92E-06	2.20E-06	0.00E+00	5.50E-06	0.00E+00	2.59E-03
Infant	2.80E-05	1.15E-05	1.57E-06	0.00E+00	4.63E-06	0.00E+00	1.61E-03

Dose factor - liquid release pathway (mrem/Ci released)							
Pr-143							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.69E-07	2.28E-07	2.82E-08	0.00E+00	1.32E-07	0.00E+00	2.49E-03
Teen	6.00E-07	2.40E-07	2.99E-08	0.00E+00	1.39E-07	0.00E+00	1.97E-03
Child	1.07E-06	3.21E-07	5.31E-08	0.00E+00	1.74E-07	0.00E+00	1.15E-03
Infant	6.81E-07	2.55E-07	3.38E-08	0.00E+00	9.47E-08	0.00E+00	3.60E-04

Dose factor - liquid release pathway (mrem/Ci released)							
Pr-144							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.76E-22	1.56E-22	2.24E-23	0.00E+00	8.80E-23	0.00E+00	5.41E-29
Teen	4.09E-22	1.67E-22	3.91E-23	0.00E+00	9.61E-23	0.00E+00	4.51E-25
Child	5.29E-22	1.64E-22	3.05E-23	0.00E+00	8.66E-23	0.00E+00	3.52E-19
Infant	1.72E-59	6.66E-60	8.67E-61	0.00E+00	2.41E-60	0.00E+00	3.10E-55

Dose factor - liquid release pathway (mrem/Ci released)							
Nd-147							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.82E-07	4.42E-07	1.13E-07	0.00E+00	2.58E-07	0.00E+00	2.12E-03
Teen	4.23E-07	4.60E-07	5.09E-07	0.00E+00	2.70E-07	0.00E+00	1.66E-03
Child	7.45E-07	6.03E-07	1.47E-07	0.00E+00	3.31E-07	0.00E+00	9.55E-04
Infant	4.53E-07	4.65E-07	2.85E-08	0.00E+00	1.79E-07	0.00E+00	2.95E-04

Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Eu-152							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.31E-05	2.99E-04	1.63E-04	0.00E+00	1.85E-05	0.00E+00	1.72E-03
Teen	1.21E-05	2.92E-06	9.00E-04	0.00E+00	1.35E-05	0.00E+00	1.07E-03
Child	1.84E-05	3.34E-06	1.91E-04	0.00E+00	1.41E-05	0.00E+00	5.49E-04
Infant	6.27E-06	1.67E-06	1.40E-06	0.00E+00	4.67E-06	0.00E+00	1.48E-04

Dose factor - liquid release pathway (mrem/Ci released)							
W-187							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	1.52E-04	1.27E-04	4.45E-05	0.00E+00	0.00E+00	0.00E+00	4.17E-02
Teen	1.65E-04	1.34E-04	4.71E-05	0.00E+00	0.00E+00	0.00E+00	3.63E-02
Child	2.09E-04	1.24E-04	5.57E-05	0.00E+00	0.00E+00	0.00E+00	1.74E-02
Infant	2.25E-06	1.57E-06	5.41E-07	0.00E+00	0.00E+00	0.00E+00	9.21E-05

Dose factor - liquid release pathway (mrem/Ci released)							
Np-239							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.15E-08	3.09E-09	2.30E-08	0.00E+00	9.65E-09	0.00E+00	6.34E-04
Teen	3.42E-08	3.22E-09	1.21E-07	0.00E+00	1.01E-08	0.00E+00	5.19E-04
Child	6.77E-08	4.86E-09	2.83E-08	0.00E+00	1.41E-08	0.00E+00	3.60E-04
Infant	5.72E-08	5.12E-09	2.89E-09	0.00E+00	1.02E-08	0.00E+00	1.48E-04

Dose factor - liquid release pathway (mrem/Ci released)							
U-235							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	3.05E-02	0.00E+00	1.89E-03	0.00E+00	7.13E-03	0.00E+00	2.98E-03
Teen	3.17E-02	0.00E+00	2.13E-03	0.00E+00	7.43E-03	0.00E+00	2.30E-03
Child	6.92E-02	0.00E+00	4.23E-03	0.00E+00	1.14E-02	0.00E+00	1.63E-03
Infant	4.42E-02	0.00E+00	3.37E-03	0.00E+00	9.40E-03	0.00E+00	7.67E-04

Dose factor - liquid release pathway (mrem/Ci released)							
U-238							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	2.92E-02	0.00E+00	1.73E-03	0.00E+00	6.67E-03	0.00E+00	2.10E-03
Teen	3.03E-02	0.00E+00	1.81E-03	0.00E+00	6.96E-03	0.00E+00	1.62E-03
Child	6.62E-02	0.00E+00	3.93E-03	0.00E+00	1.06E-02	0.00E+00	1.15E-03
Infant	4.23E-02	0.00E+00	3.15E-03	0.00E+00	8.78E-03	0.00E+00	5.41E-04

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Table 5.1-1

Dose factor - liquid release pathway (mrem/Ci released)							
Am-241							
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI
Adult	5.25E-02	1.85E-02	3.47E-03	0.00E+00	2.61E-02	0.00E+00	4.75E-03
Teen	4.10E-02	1.56E-02	2.77E-03	0.00E+00	2.05E-02	0.00E+00	3.74E-03
Child	4.10E-02	1.83E-02	2.93E-03	0.00E+00	1.79E-02	0.00E+00	2.19E-03
Infant	1.42E-02	6.68E-03	1.01E-03	0.00E+00	6.10E-03	0.00E+00	7.17E-04

Table 5.1-2

5.1.2 Atmospheric Release Mode: Radioiodine, Tritium, and Particulates

The dose calculations for demonstration of compliance with the 10 CFR 50, Appendix I dose limits for radioiodines, tritium, and particulate radionuclides released to the atmosphere will be done in the manner similar to the liquid release dose calculations described in Section 5.1.1. The total dose is compared to the corresponding atmospheric release mode Appendix I dose limit for the organ in question.

The doses are calculated using the following formula:

$$API = \Sigma\ Dose_{aomi} = \Sigma\ (TDF_{aomi} \times C_i) \leq K_{om}\ mrem$$

Where

API = the Appendix I dose for compliance evaluations in mrem

$Dose_{aomi}$ = the dose to the specific age group (a) and organ (o) via release mode (m) from radionuclide (i)

TDF_{aomi} = total dose factor for the specific age group (a) and organ (o) via release mode (m) from radionuclide (i) from Table 5.1-2 in mrem/Ci

C_i = curies of radionuclide (i) released

K_{om} = the Appendix I dose limit for organ (o) and release mode (m) for which the calculation is being made.

The methodology and the values used to obtain the TDF_{aomi} values are given in Appendix C.

It is recognized that some of the release quantities may not be available at the end of the month because the samples from these release paths are sent to a vendor for analysis. Usually, the only radionuclides affected by these delays are Sr-89 and Sr-90. Because the quantities of these two radionuclides are but a small fraction of the total release, the absence of their dose contributions from the initial monthly dose calculation will not significantly affect the total dose obtained from the remaining radionuclides. The dose for the month will be updated upon the receipt of the vendor isotopic results and upon the receipt of any corrections to previous release quantities.

Instead of using the precalculated total dose factors, the Appendix I dose calculation may be modified to reflect the actual χ/Q during the release period using the methodology of Appendix C.

TABLE 5.1-2
AIRBORNE EFFLUENT DOSE FACTOR

Summations of dose per curie released were made for calculations over the pathways: ingestion of produce, leafy vegetables, milk, meat; inhalation of airborne radionuclides, and direct exposure to deposited radioactivity.

Dose factor - airborne release pathway (mrem/Ci released)								
H-3								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	2.34E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04	2.34E-04	0.00E+00
Teen	0.00E+00	2.69E-04	2.69E-04	2.69E-04	2.69E-04	2.69E-04	2.69E-04	0.00E+00
Child	0.00E+00	3.93E-04	3.93E-04	3.93E-04	3.93E-04	3.93E-04	3.93E-04	0.00E+00
Infant	0.00E+00	1.73E-04	1.73E-04	1.73E-04	1.73E-04	1.73E-04	1.73E-04	0.00E+00

Dose factor - airborne release pathway (mrem/Ci released)								
F-18								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.12E-04	0.00E+00	9.61E-04	0.00E+00	0.00E+00	0.00E+00	2.19E-06	2.23E-03
Teen	1.55E-04	0.00E+00	9.65E-04	0.00E+00	0.00E+00	0.00E+00	9.23E-06	2.23E-03
Child	2.06E-04	0.00E+00	9.69E-04	0.00E+00	0.00E+00	0.00E+00	3.70E-05	2.23E-03
Infant	1.63E-04	0.00E+00	9.62E-04	0.00E+00	0.00E+00	0.00E+00	2.53E-05	2.23E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Na-22								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.83E+00	4.83E+00	2.89E+01	4.83E+00	4.83E+00	4.83E+00	4.83E+00	3.79E+01
Teen	7.41E+00	7.41E+00	3.15E+01	7.41E+00	7.41E+00	7.41E+00	7.41E+00	3.79E+01
Child	1.50E+01	1.50E+01	3.90E+01	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.79E+01
Infant	1.81E+01	1.81E+01	4.21E+01	1.81E+01	1.81E+01	1.81E+01	1.81E+01	3.79E+01

Dose factor - airborne release pathway (mrem/Ci released)								
Na-24								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	9.48E-04	9.48E-04	1.77E-02	9.48E-04	9.48E-04	9.48E-04	9.48E-04	7.64E-02
Teen	1.36E-03	1.36E-03	1.81E-02	1.36E-03	1.36E-03	1.36E-03	1.36E-03	7.64E-02
Child	2.37E-03	2.37E-03	1.91E-02	2.37E-03	2.37E-03	2.37E-03	2.37E-03	7.64E-02
Infant	3.14E-03	3.14E-03	1.99E-02	3.14E-03	3.14E-03	3.14E-03	3.14E-03	7.64E-02

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Sc-46								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.33E-02	2.59E-02	2.00E+00	0.00E+00	2.42E-02	0.00E+00	2.40E+00	2.69E+00
Teen	1.75E-02	3.41E-02	2.00E+00	0.00E+00	3.26E-02	0.00E+00	2.09E+00	2.69E+00
Child	2.23E-02	3.05E-02	2.00E+00	0.00E+00	2.70E-02	0.00E+00	1.32E+00	2.69E+00
Infant	1.56E-02	2.25E-02	2.00E+00	0.00E+00	1.48E-02	0.00E+00	1.35E-03	2.69E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Mn-54								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	2.32E-01	1.99E+00	0.00E+00	6.89E-02	4.15E-02	7.08E-01	2.28E+00
Teen	0.00E+00	3.34E-01	2.01E+00	0.00E+00	9.95E-02	5.89E-02	6.83E-01	2.28E+00
Child	0.00E+00	4.86E-01	2.07E+00	0.00E+00	1.36E-01	4.68E-02	4.08E-01	2.28E+00
Infant	0.00E+00	2.03E-02	1.95E+00	0.00E+00	4.47E-03	2.97E-02	7.38E-03	2.28E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Cr-51								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	0.00E+00	6.59E-03	2.68E-05	9.86E-06	4.83E-04	1.07E-02	7.73E-03
Teen	0.00E+00	0.00E+00	6.60E-03	3.39E-05	1.34E-05	7.03E-04	9.66E-03	7.73E-03
Child	0.00E+00	0.00E+00	6.66E-03	6.30E-05	1.72E-05	6.14E-04	5.81E-03	7.73E-03
Infant	0.00E+00	0.00E+00	6.58E-03	2.42E-05	5.31E-06	4.25E-04	1.02E-03	7.73E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Mn-56								
	Bone	Liver	T.Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	4.81E-08	1.27E-03	0.00E+00	5.31E-08	2.80E-04	6.01E-04	1.50E-03
Teen	0.00E+00	6.05E-08	1.27E-03	0.00E+00	6.61E-08	4.51E-04	1.70E-03	1.50E-03
Child	0.00E+00	6.26E-08	1.27E-03	0.00E+00	6.58E-08	3.90E-04	3.66E-03	1.50E-03
Infant	0.00E+00	4.57E-08	1.27E-03	0.00E+00	3.27E-08	3.72E-04	2.13E-03	1.50E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Fe-55								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.20E-01	2.21E-01	5.15E-02	0.00E+00	0.00E+00	1.25E-01	1.27E-01	0.00E+00
Teen	3.80E-01	2.70E-01	6.29E-02	0.00E+00	0.00E+00	1.74E-01	1.17E-01	0.00E+00
Child	8.65E-01	4.59E-01	1.42E-01	0.00E+00	0.00E+00	2.62E-01	8.49E-02	0.00E+00
Infant	7.36E-02	4.75E-02	1.27E-02	0.00E+00	0.00E+00	2.56E-02	6.02E-03	0.00E+00

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Fe-59								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.01E-01	4.73E-01	5.65E-01	0.00E+00	0.00E+00	1.62E-01	1.58E+00	4.50E-01
Teen	2.25E-01	5.24E-01	5.86E-01	0.00E+00	0.00E+00	2.10E-01	1.24E+00	4.50E-01
Child	4.62E-01	7.48E-01	7.56E-01	0.00E+00	0.00E+00	2.54E-01	7.80E-01	4.50E-01
Infant	6.14E-02	1.07E-01	4.26E-01	0.00E+00	0.00E+00	6.16E-02	5.16E-02	4.50E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Co-57								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	1.17E-02	4.93E-01	0.00E+00	0.00E+00	1.10E-02	2.97E-01	6.13E-01
Teen	0.00E+00	1.59E-02	5.00E-01	0.00E+00	0.00E+00	1.74E-02	2.97E-01	6.13E-01
Child	0.00E+00	2.57E-02	5.26E-01	0.00E+00	0.00E+00	1.50E-02	2.11E-01	6.13E-01
Infant	0.00E+00	4.38E-03	4.81E-01	0.00E+00	0.00E+00	1.13E-02	1.50E-02	6.13E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Co-58								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	3.14E-02	6.02E-01	0.00E+00	0.00E+00	2.75E-02	6.38E-01	6.23E-01
Teen	0.00E+00	4.00E-02	6.24E-01	0.00E+00	0.00E+00	3.99E-02	5.53E-01	6.23E-01
Child	0.00E+00	5.73E-02	7.07E-01	0.00E+00	0.00E+00	3.28E-02	3.35E-01	6.23E-01
Infant	0.00E+00	9.90E-03	5.57E-01	0.00E+00	0.00E+00	2.31E-02	2.49E-02	6.23E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Co-60								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	1.68E-01	3.06E+01	0.00E+00	0.00E+00	1.77E-01	3.16E+00	3.56E+01
Teen	0.00E+00	2.23E-01	3.07E+01	0.00E+00	0.00E+00	2.59E-01	2.90E+00	3.56E+01
Child	0.00E+00	3.28E-01	3.12E+01	0.00E+00	0.00E+00	2.10E-01	1.82E+00	3.56E+01
Infant	0.00E+00	5.86E-02	3.04E+01	0.00E+00	0.00E+00	1.34E-01	1.40E-01	3.56E+01

Dose factor - airborne release pathway (mrem/Ci released)								
Ni-63								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.39E+01	1.65E+00	8.00E-01	0.00E+00	0.00E+00	5.29E-03	3.45E-01	0.00E+00
Teen	2.93E+01	2.07E+00	9.92E-01	0.00E+00	0.00E+00	9.11E-03	3.29E-01	0.00E+00
Child	6.73E+01	3.60E+00	2.29E+00	0.00E+00	0.00E+00	8.16E-03	2.43E-01	0.00E+00
Infant	2.11E+01	1.30E+00	7.32E-01	0.00E+00	0.00E+00	6.19E-03	6.49E-02	0.00E+00

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Ni-65								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	8.95E-08	1.19E-08	4.17E-04	0.00E+00	0.00E+00	1.66E-04	3.66E-04	4.85E-04
Teen	1.06E-07	1.39E-08	4.17E-04	0.00E+00	0.00E+00	2.78E-04	1.09E-03	4.85E-04
Child	1.64E-07	1.58E-08	4.17E-04	0.00E+00	0.00E+00	2.43E-04	2.49E-03	4.85E-04
Infant	7.17E-08	8.51E-09	4.17E-04	0.00E+00	0.00E+00	2.41E-04	1.49E-03	4.85E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Cu-64								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	1.12E-05	8.57E-04	0.00E+00	2.82E-05	2.01E-04	2.40E-03	9.65E-04
Teen	0.00E+00	1.40E-05	8.58E-04	0.00E+00	3.54E-05	3.30E-04	2.90E-03	9.65E-04
Child	0.00E+00	2.19E-05	8.65E-04	0.00E+00	5.28E-05	2.84E-04	2.11E-03	9.65E-04
Infant	0.00E+00	3.42E-05	8.68E-04	0.00E+00	5.79E-05	2.76E-04	1.15E-03	9.65E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Zn-65								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.21E+00	3.85E+00	2.79E+00	0.00E+00	2.57E+00	2.56E-02	2.42E+00	1.21E+00
Teen	1.63E+00	5.67E+00	3.69E+00	0.00E+00	3.63E+00	3.68E-02	2.40E+00	1.21E+00
Child	3.12E+00	8.31E+00	6.22E+00	0.00E+00	5.24E+00	2.95E-02	1.46E+00	1.21E+00
Infant	2.95E+00	1.01E+01	5.71E+00	0.00E+00	4.91E+00	1.92E-02	8.54E+00	1.21E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Zn-69								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.01E-06	5.76E-06	4.01E-07	0.00E+00	3.74E-06	2.73E-05	1.35E-06	0.00E+00
Teen	4.64E-06	8.83E-06	6.18E-07	0.00E+00	5.77E-06	4.70E-05	2.47E-05	0.00E+00
Child	1.08E-05	1.56E-05	1.45E-06	0.00E+00	9.49E-06	4.22E-05	1.29E-03	0.00E+00
Infant	1.93E-05	3.48E-05	2.59E-06	0.00E+00	1.45E-05	4.36E-05	3.23E-03	0.00E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Zn-69m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.99E-05	1.20E-04	3.07E-03	0.00E+00	7.26E-05	5.65E-04	1.13E-02	5.74E-03
Teen	7.60E-05	1.79E-04	3.07E-03	0.00E+00	1.09E-04	9.30E-04	1.49E-02	5.74E-03
Child	1.76E-04	3.00E-04	3.09E-03	0.00E+00	1.74E-04	8.08E-04	1.27E-02	5.74E-03
Infant	3.11E-04	6.35E-04	3.12E-03	0.00E+00	2.57E-04	7.93E-04	1.00E-02	5.74E-03

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Br-82								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	0.00E+00	5.44E-02	0.00E+00	0.00E+00	0.00E+00	8.47E-03	6.41E-02
Teen	0.00E+00	0.00E+00	5.89E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E-02
Child	0.00E+00	0.00E+00	7.04E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E-02
Infant	0.00E+00	0.00E+00	8.32E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Br-83								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	0.00E+00	1.65E-05	0.00E+00	0.00E+00	0.00E+00	6.89E-06	2.84E-03
Teen	0.00E+00	0.00E+00	1.96E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-03
Child	0.00E+00	0.00E+00	2.34E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-03
Infant	0.00E+00	0.00E+00	2.07E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Br-84								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	0.00E+00	2.59E-02	0.00E+00	0.00E+00	0.00E+00	1.11E-09	2.49E-01
Teen	0.00E+00	0.00E+00	2.60E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01
Child	0.00E+00	0.00E+00	2.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01
Infant	0.00E+00	0.00E+00	2.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Br-85								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	0.00E+00	4.95E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-04
Teen	0.00E+00	0.00E+00	7.06E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-04
Child	0.00E+00	0.00E+00	2.02E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-04
Infant	0.00E+00	0.00E+00	4.21E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Rb-86								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	8.21E-01	3.95E-01	0.00E+00	0.00E+00	0.00E+00	1.61E-01	1.44E-02
Teen	0.00E+00	1.23E+00	5.92E-01	0.00E+00	0.00E+00	0.00E+00	1.82E-01	1.44E-02
Child	0.00E+00	2.18E+00	1.35E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-01	1.44E-02
Infant	0.00E+00	4.17E+00	2.07E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-01	1.44E-02

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Rb-88								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	1.15E-05	5.22E-05	0.00E+00	0.00E+00	0.00E+00	9.92E-17	5.31E-05
Teen	0.00E+00	1.62E-05	5.45E-05	0.00E+00	0.00E+00	0.00E+00	8.66E-13	5.31E-05
Child	0.00E+00	1.67E-05	5.73E-05	0.00E+00	0.00E+00	0.00E+00	5.12E-07	5.31E-05
Infant	0.00E+00	1.65E-05	5.50E-05	0.00E+00	0.00E+00	0.00E+00	1.01E-05	5.31E-05

Dose factor - airborne release pathway (mrem/Ci released)								
Rb-89								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	7.60E-06	1.78E-04	0.00E+00	0.00E+00	0.00E+00	2.75E-19	2.07E-04
Teen	0.00E+00	1.04E-05	1.80E-04	0.00E+00	0.00E+00	0.00E+00	1.00E-14	2.07E-04
Child	0.00E+00	1.02E-05	1.81E-04	0.00E+00	0.00E+00	0.00E+00	5.61E-08	2.07E-04
Infant	0.00E+00	9.51E-06	1.79E-04	0.00E+00	0.00E+00	0.00E+00	2.02E-06	2.07E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Sr-89								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	7.63E+00	0.00E+00	2.19E-01	0.00E+00	0.00E+00	4.15E-02	1.23E+00	3.53E-05
Teen	1.16E+01	0.00E+00	3.34E-01	0.00E+00	0.00E+00	7.17E-02	1.40E+00	3.53E-05
Child	2.77E+01	0.00E+00	7.90E-01	0.00E+00	0.00E+00	6.40E-02	1.08E+00	3.53E-05
Infant	3.66E+00	0.00E+00	1.05E-01	0.00E+00	0.00E+00	6.02E-02	7.69E-02	3.53E-05

Dose factor - airborne release pathway (mrem/Ci released)								
Sr-90								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	5.10E+02	0.00E+00	1.25E+02	0.00E+00	0.00E+00	2.85E-01	1.47E+01	0.00E+00
Teen	6.33E+02	0.00E+00	1.56E+02	0.00E+00	0.00E+00	4.89E-01	1.77E+01	0.00E+00
Child	1.05E+03	0.00E+00	2.65E+02	0.00E+00	0.00E+00	4.38E-01	1.41E+01	0.00E+00
Infant	7.33E+01	0.00E+00	1.84E+01	0.00E+00	0.00E+00	3.34E-01	9.04E-01	0.00E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Sr-91								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.29E-04	0.00E+00	3.03E-03	0.00E+00	0.00E+00	1.08E-03	6.76E-03	3.53E-03
Teen	2.20E-04	0.00E+00	3.03E-03	0.00E+00	0.00E+00	1.80E-03	8.68E-03	3.53E-03
Child	4.09E-04	0.00E+00	3.03E-03	0.00E+00	0.00E+00	1.58E-03	6.06E-03	3.53E-03
Infant	5.29E-05	0.00E+00	3.02E-03	0.00E+00	0.00E+00	1.56E-03	2.24E-03	3.53E-03

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Sr-92								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	5.04E-07	0.00E+00	1.65E-03	0.00E+00	0.00E+00	4.89E-04	1.28E-03	3.15E-03
Teen	5.66E-07	0.00E+00	1.65E-03	0.00E+00	0.00E+00	8.14E-04	3.54E-03	3.15E-03
Child	9.08E-07	0.00E+00	1.65E-03	0.00E+00	0.00E+00	7.12E-04	7.20E-03	3.15E-03
Infant	3.12E-07	0.00E+00	1.65E-03	0.00E+00	0.00E+00	7.06E-04	4.15E-03	3.15E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Y-90								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	7.17E-05	0.00E+00	8.23E-06	0.00E+00	0.00E+00	5.03E-03	1.19E-01	7.45E-06
Teen	9.77E-05	0.00E+00	8.93E-06	0.00E+00	0.00E+00	8.69E-03	9.20E-02	7.45E-06
Child	1.39E-04	0.00E+00	1.00E-05	0.00E+00	0.00E+00	7.76E-03	5.63E-02	7.45E-06
Infant	9.77E-05	0.00E+00	8.93E-06	0.00E+00	0.00E+00	7.98E-03	3.26E-03	7.45E-06

Dose factor - airborne release pathway (mrem/Ci released)								
Y-91								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.78E-02	0.00E+00	1.98E-03	0.00E+00	0.00E+00	5.06E-02	2.26E+00	1.70E-03
Teen	2.55E-02	0.00E+00	2.19E-03	0.00E+00	0.00E+00	8.71E-02	2.44E+00	1.70E-03
Child	4.10E-02	0.00E+00	2.60E-03	0.00E+00	0.00E+00	7.79E-02	1.86E+00	1.70E-03
Infant	1.75E-02	0.00E+00	1.97E-03	0.00E+00	0.00E+00	7.27E-02	3.72E-03	1.70E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Y-91m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.58E-06	0.00E+00	2.31E-04	0.00E+00	0.00E+00	5.70E-05	1.05E-05	4.33E-04
Teen	6.15E-06	0.00E+00	2.31E-04	0.00E+00	0.00E+00	9.49E-05	2.91E-04	4.33E-04
Child	1.50E-05	0.00E+00	2.31E-04	0.00E+00	0.00E+00	8.34E-05	2.94E-02	4.33E-04
Infant	1.21E-08	0.00E+00	2.31E-04	0.00E+00	0.00E+00	8.27E-05	6.98E-05	4.33E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Y-92								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.35E-05	0.00E+00	4.38E-04	0.00E+00	0.00E+00	4.65E-04	5.83E-01	2.90E-02
Teen	5.80E-05	0.00E+00	4.39E-04	0.00E+00	0.00E+00	7.95E-04	1.58E+00	2.90E-02
Child	1.42E-04	0.00E+00	4.41E-04	0.00E+00	0.00E+00	7.09E-04	4.09E+00	2.90E-02
Infant	4.86E-07	0.00E+00	4.37E-04	0.00E+00	0.00E+00	7.27E-04	3.76E-03	2.90E-02

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Y-93								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.08E-04	0.00E+00	4.43E-04	0.00E+00	0.00E+00	1.44E-03	3.35E+00	6.58E-02
Teen	1.86E-04	0.00E+00	4.45E-04	0.00E+00	0.00E+00	2.47E-03	5.59E+00	6.58E-02
Child	4.53E-04	0.00E+00	4.52E-04	0.00E+00	0.00E+00	2.21E-03	6.69E+00	6.58E-02
Infant	4.45E-06	0.00E+00	4.40E-04	0.00E+00	0.00E+00	2.27E-03	4.95E-03	6.58E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Zr-95								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.79E-03	1.54E-03	3.45E-01	0.00E+00	2.42E-03	5.25E-02	1.64E+00	3.98E-01
Teen	6.16E-03	1.94E-03	3.45E-01	0.00E+00	2.85E-03	7.98E-02	1.35E+00	3.98E-01
Child	9.47E-03	2.08E-03	3.45E-01	0.00E+00	2.97E-03	6.62E-02	8.81E-01	3.98E-01
Infant	3.43E-03	8.27E-04	3.44E-01	0.00E+00	9.23E-04	5.19E-02	9.12E-04	3.98E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Zr-97								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.12E-06	6.31E-07	4.16E-03	0.00E+00	9.56E-07	2.34E-03	3.09E-02	4.84E-03
Teen	4.31E-06	8.52E-07	4.16E-03	0.00E+00	1.29E-06	3.85E-03	3.09E-02	4.84E-03
Child	5.98E-06	8.66E-07	4.16E-03	0.00E+00	1.24E-06	3.36E-03	1.95E-02	4.84E-03
Infant	4.45E-06	7.60E-07	4.16E-03	0.00E+00	7.69E-07	3.27E-03	4.16E-03	4.84E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Nb-95								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.39E-03	7.75E-04	1.92E-01	0.00E+00	7.67E-04	1.50E-02	3.30E+00	2.26E-01
Teen	1.39E-03	7.72E-04	1.92E-01	0.00E+00	7.48E-04	2.23E-02	1.99E+00	2.26E-01
Child	2.22E-03	8.65E-04	1.93E-01	0.00E+00	8.13E-04	1.82E-02	1.10E+00	2.26E-01
Infant	6.08E-04	2.49E-04	1.92E-01	0.00E+00	1.82E-04	1.42E-02	4.99E-02	2.26E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Nb-97								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.05E-06	5.17E-07	4.17E-04	0.00E+00	6.03E-07	7.12E-05	1.91E-03	3.20E-03
Teen	3.50E-06	8.68E-07	4.17E-04	0.00E+00	1.02E-06	1.17E-04	2.07E-02	3.20E-03
Child	8.49E-06	1.53E-06	4.17E-04	0.00E+00	1.70E-06	1.01E-04	4.73E-01	3.20E-03
Infant	1.01E-08	2.16E-09	4.17E-04	0.00E+00	1.69E-09	9.84E-05	7.98E-04	3.20E-03

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Mo-99								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	0.00E+00	9.10E-03	7.34E-03	0.00E+00	2.06E-02	2.71E-03	2.85E-02	6.50E-03
Teen	0.00E+00	1.24E-02	7.97E-03	0.00E+00	2.84E-02	4.56E-03	3.02E-02	6.50E-03
Child	0.00E+00	2.06E-02	1.07E-02	0.00E+00	4.41E-02	4.02E-03	2.08E-02	6.50E-03
Infant	0.00E+00	3.82E-02	1.31E-02	0.00E+00	5.70E-02	4.00E-03	1.40E-02	6.50E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Tc-99m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.92E-09	8.24E-09	2.59E-04	0.00E+00	1.25E-07	2.27E-05	1.28E-04	2.96E-04
Teen	3.11E-09	8.68E-09	2.59E-04	0.00E+00	1.29E-07	3.42E-05	1.87E-04	2.96E-04
Child	5.95E-09	1.17E-08	2.59E-04	0.00E+00	1.69E-07	2.82E-05	1.49E-04	2.96E-04
Infant	5.14E-09	1.06E-08	2.59E-04	0.00E+00	1.14E-07	2.41E-05	6.33E-05	2.96E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Tc-101								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.16E-05	1.67E-05	2.08E-04	0.00E+00	3.01E-04	2.04E-05	5.06E-17	5.80E-04
Teen	1.99E-05	2.83E-05	3.23E-04	0.00E+00	5.12E-04	3.71E-05	4.87E-12	5.80E-04
Child	4.89E-05	5.12E-05	6.93E-04	0.00E+00	8.72E-04	4.44E-05	1.63E-04	5.80E-04
Infant	1.93E-12	2.44E-12	4.44E-05	0.00E+00	2.90E-11	1.73E-05	2.50E-05	5.80E-04

Dose factor - airborne release pathway (mrem/Ci released)								
Ru-103								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.36E-02	0.00E+00	1.71E-01	0.00E+00	1.66E-01	1.50E-02	5.08E+00	1.77E-01
Teen	3.76E-02	0.00E+00	1.68E-01	0.00E+00	1.33E-01	2.32E-02	3.14E+00	1.77E-01
Child	7.01E-02	0.00E+00	1.79E-01	0.00E+00	1.77E-01	1.97E-02	1.81E+00	1.77E-01
Infant	6.20E-05	0.00E+00	1.52E-01	0.00E+00	1.30E-04	1.64E-02	5.05E-04	1.77E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Ru-105								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	6.19E-04	0.00E+00	2.07E-03	0.00E+00	7.99E-03	3.25E-04	3.80E-01	1.02E-02
Teen	1.06E-03	0.00E+00	2.23E-03	0.00E+00	1.34E-02	5.39E-04	8.59E-01	1.02E-02
Child	2.59E-03	0.00E+00	2.76E-03	0.00E+00	2.28E-02	4.72E-04	1.69E+00	1.02E-02
Infant	3.63E-08	0.00E+00	1.82E-03	0.00E+00	2.67E-08	4.65E-04	1.44E-03	1.02E-02

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Ru-106								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.65E+00	0.00E+00	8.01E-01	0.00E+00	3.18E+00	2.78E-01	1.06E+02	7.11E-01
Teen	1.49E+00	0.00E+00	7.81E-01	0.00E+00	2.88E+00	4.77E-01	7.16E+01	7.11E-01
Child	2.93E+00	0.00E+00	9.58E-01	0.00E+00	3.96E+00	4.25E-01	4.55E+01	7.11E-01
Infant	2.67E-03	0.00E+00	5.93E-01	0.00E+00	3.28E-03	3.43E-01	5.60E-03	7.11E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Rh-105								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.81E-02	3.52E-02	2.47E-02	0.00E+00	1.50E-01	5.72E-04	5.61E+00	7.74E-03
Teen	8.33E-02	6.02E-02	4.10E-02	0.00E+00	2.56E-01	9.71E-04	7.66E+00	7.74E-03
Child	2.04E-01	1.10E-01	9.53E-02	0.00E+00	4.37E-01	8.59E-04	6.80E+00	7.74E-03
Infant	7.15E-04	4.68E-04	1.83E-03	0.00E+00	1.30E-03	8.64E-04	1.22E-02	7.74E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Ag-110m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.10E-02	3.80E-02	4.85E+00	0.00E+00	7.47E-02	1.37E-01	1.54E+01	5.63E+00
Teen	6.28E-02	5.94E-02	4.86E+00	0.00E+00	1.13E-01	2.00E-01	1.66E+01	5.63E+00
Child	1.34E-01	9.04E-02	4.90E+00	0.00E+00	1.68E-01	1.62E-01	1.07E+01	5.63E+00
Infant	1.93E-01	1.41E-01	4.92E+00	0.00E+00	2.02E-01	1.09E-01	7.31E+00	5.63E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Sb-124								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.44E-01	2.73E-03	1.36E+00	3.50E-04	0.00E+00	1.85E-01	4.09E+00	4.02E+00
Teen	2.22E-01	4.09E-03	1.39E+00	5.03E-04	0.00E+00	3.07E-01	4.46E+00	4.02E+00
Child	5.11E-01	6.63E-03	1.48E+00	1.13E-03	0.00E+00	3.79E-01	3.19E+00	4.02E+00
Infant	6.72E-02	9.90E-04	1.32E+00	1.78E-04	0.00E+00	1.20E-01	2.06E-01	4.02E+00

Dose factor - airborne release pathway (mrem/Ci released)								
Sb-125								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.07E-01	1.20E-03	5.38E+00	1.09E-04	0.00E+00	1.33E-01	1.17E+00	9.11E+00
Teen	1.61E-01	1.76E-03	5.39E+00	1.54E-04	0.00E+00	2.21E-01	1.24E+00	9.11E+00
Child	3.69E-01	2.84E-03	5.43E+00	3.42E-04	0.00E+00	2.73E-01	8.75E-01	9.11E+00
Infant	8.33E-02	8.05E-04	5.37E+00	1.04E-04	0.00E+00	9.99E-02	1.09E-01	9.11E+00

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Te-125m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.87E-01	1.40E-01	6.67E-02	1.16E-01	1.57E+00	9.30E-03	1.55E+00	3.96E-02
Teen	5.11E-01	1.84E-01	8.32E-02	1.43E-01	0.00E+00	1.59E-02	1.51E+00	3.96E-02
Child	1.17E+00	3.16E-01	1.70E-01	3.27E-01	0.00E+00	1.42E-02	1.13E+00	3.96E-02
Infant	5.10E-02	1.71E-02	2.18E-02	1.72E-02	0.00E+00	1.33E-02	2.46E-02	3.96E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Te-127								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.47E-06	1.61E-06	5.15E-06	3.31E-06	1.82E-05	1.93E-04	2.05E-03	4.60E-06
Teen	4.34E-06	1.55E-06	5.12E-06	3.00E-06	1.76E-05	3.32E-04	2.73E-03	4.60E-06
Child	8.13E-06	2.20E-06	5.93E-06	5.63E-06	2.31E-05	2.98E-04	1.98E-03	4.60E-06
Infant	1.25E-06	4.25E-07	4.45E-06	1.02E-06	3.03E-06	3.07E-04	7.48E-04	4.60E-06

Dose factor - airborne release pathway (mrem/Ci released)								
Te-127m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.19E+00	4.26E-01	1.54E-01	3.05E-01	4.84E+00	2.85E-02	4.00E+00	6.16E-02
Teen	1.48E+00	5.26E-01	1.85E-01	3.52E-01	6.01E+00	4.91E-02	3.70E+00	6.16E-02
Child	3.32E+00	8.94E-01	4.03E-01	7.94E-01	9.47E+00	4.39E-02	2.69E+00	6.16E-02
Infant	1.96E-01	6.50E-02	3.26E-02	5.66E-02	4.82E-01	3.89E-02	7.96E-02	6.16E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Te-129								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.48E-09	7.10E-10	3.68E-05	1.16E-09	5.56E-09	5.74E-05	4.65E-06	4.36E-05
Teen	2.11E-09	1.00E-09	3.68E-05	1.54E-09	7.88E-09	9.78E-05	4.79E-05	4.36E-05
Child	2.90E-09	1.04E-09	3.68E-05	2.12E-09	7.62E-09	8.71E-05	7.56E-04	4.36E-05
Infant	2.34E-09	1.03E-09	3.68E-05	2.00E-09	5.19E-09	8.89E-05	7.81E-04	4.36E-05

Dose factor - airborne release pathway (mrem/Ci released)								
Te-129m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.39E+00	5.19E-01	2.35E-01	4.78E-01	5.80E+00	3.44E-02	7.01E+00	9.07E-01
Teen	1.94E+00	7.20E-01	3.22E-01	6.26E-01	8.12E+00	5.86E-02	7.30E+00	9.07E-01
Child	4.53E+00	1.26E+00	7.18E-01	1.46E+00	1.33E+01	5.23E-02	5.53E+00	9.07E-01
Infant	1.39E-01	4.77E-02	3.66E-02	5.34E-02	3.48E-01	4.98E-02	8.46E-02	9.07E-01

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Te-131								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.47E-03	6.14E-04	5.56E-04	1.21E-03	6.43E-03	4.13E-05	2.09E-04	1.63E-03
Teen	2.52E-03	1.04E-03	8.80E-04	1.94E-03	1.10E-02	6.93E-05	2.07E-04	1.63E-03
Child	6.19E-03	1.89E-03	1.93E-03	4.73E-03	1.87E-02	6.09E-05	3.25E-02	1.63E-03
Infant	5.15E-10	2.44E-10	9.27E-05	4.69E-10	1.18E-09	6.11E-05	2.44E-04	1.63E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Te-131m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.30E-01	6.34E-02	7.45E-02	1.00E-01	6.43E-01	4.32E-03	6.32E+00	3.77E-02
Teen	2.21E-01	1.06E-01	1.10E-01	1.60E-01	1.11E+00	7.05E-03	8.53E+00	3.77E-02
Child	5.38E-01	1.86E-01	2.20E-01	3.83E-01	1.80E+00	6.10E-03	7.56E+00	3.77E-02
Infant	6.34E-04	2.56E-04	2.18E-02	5.18E-04	1.76E-03	5.90E-03	7.81E-03	3.77E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Te-132								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.92E-01	1.24E-01	1.27E-01	1.37E-01	1.20E+00	8.55E-03	5.89E+00	1.32E-02
Teen	3.19E-01	2.02E-01	2.00E-01	2.13E-01	1.94E+00	1.33E-02	6.42E+00	1.32E-02
Child	7.61E-01	3.37E-01	4.17E-01	4.91E-01	3.13E+00	1.12E-02	3.39E+00	1.32E-02
Infant	3.94E-03	1.95E-03	1.17E-02	2.88E-03	1.22E-02	1.01E-02	8.50E-03	1.32E-02

Dose factor - airborne release pathway (mrem/Ci released)								
I-131								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	7.16E-02	1.02E-01	8.29E-02	3.36E+01	1.76E-01	0.00E+00	2.69E-02	2.93E-02
Teen	6.57E-02	9.19E-02	7.35E-02	2.68E+01	1.58E-01	0.00E+00	1.81E-02	2.93E-02
Child	1.44E-01	1.45E-01	1.07E-01	4.80E+01	2.38E-01	0.00E+00	1.29E-02	2.93E-02
Infant	2.04E-01	2.40E-01	1.30E-01	7.89E+01	2.80E-01	0.00E+00	8.56E-03	2.93E-02

Dose factor - airborne release pathway (mrem/Ci released)								
I-132								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.44E-05	9.67E-05	1.78E-03	3.40E-03	1.54E-04	0.00E+00	1.21E-05	2.06E-03
Teen	4.73E-05	1.30E-04	1.80E-03	4.49E-03	2.05E-04	0.00E+00	3.78E-05	2.06E-03
Child	6.28E-05	1.21E-04	1.80E-03	5.74E-03	1.86E-04	0.00E+00	9.50E-05	2.06E-03
Infant	5.03E-05	1.05E-04	1.79E-03	5.03E-03	1.17E-04	0.00E+00	5.65E-05	2.06E-03

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
I-133								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.46E-03	2.53E-03	4.21E-03	3.71E-01	4.41E-03	0.00E+00	2.14E-03	4.19E-03
Teen	1.49E-03	2.52E-03	4.21E-03	3.53E-01	4.42E-03	0.00E+00	1.75E-03	4.19E-03
Child	2.87E-03	3.55E-03	4.78E-03	6.61E-01	5.91E-03	0.00E+00	1.35E-03	4.19E-03
Infant	3.16E-03	4.59E-03	4.79E-03	8.37E-01	5.40E-03	0.00E+00	7.45E-04	4.19E-03

Dose factor - airborne release pathway (mrem/Ci released)								
I-134								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.91E-05	5.13E-05	6.45E-04	8.85E-04	8.17E-05	0.00E+00	2.99E-08	7.45E-04
Teen	2.63E-05	6.88E-05	6.52E-04	1.17E-03	1.09E-04	0.00E+00	6.05E-07	7.45E-04
Child	3.48E-05	6.41E-05	6.57E-04	1.50E-03	9.79E-05	0.00E+00	2.83E-05	7.45E-04
Infant	2.73E-05	5.57E-05	6.47E-04	1.32E-03	6.19E-05	0.00E+00	3.83E-05	7.45E-04

Dose factor - airborne release pathway (mrem/Ci released)								
I-135								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	9.31E-05	2.43E-04	3.64E-03	1.56E-02	3.87E-04	0.00E+00	1.96E-04	4.14E-03
Teen	1.22E-04	3.12E-04	3.66E-03	2.05E-02	4.92E-04	0.00E+00	2.41E-04	4.14E-03
Child	1.69E-04	3.00E-04	3.69E-03	2.72E-02	4.61E-04	0.00E+00	1.63E-04	4.14E-03
Infant	1.23E-04	2.43E-04	3.64E-03	2.22E-02	2.70E-04	0.00E+00	6.06E-05	4.14E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Cs-134								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	6.68E+00	1.59E+01	2.26E+01	0.00E+00	5.15E+00	1.71E+00	2.78E-01	1.12E+01
Teen	1.06E+01	2.49E+01	2.12E+01	0.00E+00	7.90E+00	3.02E+00	3.09E-01	1.12E+01
Child	2.39E+01	3.93E+01	1.79E+01	0.00E+00	1.22E+01	4.37E+00	2.12E-01	1.12E+01
Infant	1.96E+01	3.66E+01	1.33E+01	0.00E+00	9.42E+00	3.86E+00	9.94E-02	1.12E+01

Dose factor - airborne release pathway (mrem/Ci released)								
Cs-134m								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	8.36E-04	1.76E-03	9.41E-04	0.00E+00	9.54E-04	1.50E-04	6.19E-04	6.90E-05
Teen	1.40E-03	2.89E-03	1.53E-03	0.00E+00	1.61E-03	2.83E-04	1.92E-03	6.90E-05
Child	3.30E-03	4.89E-03	3.24E-03	0.00E+00	2.58E-03	4.27E-04	6.18E-03	6.90E-05
Infant	5.48E-06	8.72E-06	4.70E-05	0.00E+00	3.53E-06	8.31E-07	4.82E-06	6.90E-05

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Cs-136								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.31E-01	1.31E+00	1.28E+00	0.00E+00	7.27E-01	9.97E-02	1.48E-01	4.73E-01
Teen	5.12E-01	2.02E+00	1.70E+00	0.00E+00	1.10E+00	1.73E-01	1.62E-01	4.73E-01
Child	1.14E+00	3.14E+00	2.38E+00	0.00E+00	1.67E+00	2.49E-01	1.10E-01	4.73E-01
Infant	3.54E-01	1.04E+00	7.33E-01	0.00E+00	4.15E-01	8.48E-02	1.58E-02	4.73E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Cs-137								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	9.52E+00	1.30E+01	2.30E+01	0.00E+00	4.42E+00	1.47E+00	2.52E-01	1.69E+01
Teen	1.57E+01	2.09E+01	2.18E+01	0.00E+00	7.12E+00	2.77E+00	2.97E-01	1.69E+01
Child	3.73E+01	3.57E+01	1.97E+01	0.00E+00	1.16E+01	4.18E+00	2.23E-01	1.69E+01
Infant	2.99E+01	3.49E+01	1.70E+01	0.00E+00	9.38E+00	3.80E+00	1.09E-01	1.69E+01

Dose factor - airborne release pathway (mrem/Ci released)								
Cs-138								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	2.17E-03	4.28E-03	2.70E-03	0.00E+00	3.14E-03	3.10E-04	1.82E-08	4.39E-03
Teen	3.69E-03	7.08E-03	4.13E-03	0.00E+00	5.23E-03	6.08E-04	3.21E-06	4.39E-03
Child	8.93E-03	1.24E-02	8.46E-03	0.00E+00	8.73E-03	9.40E-04	5.71E-03	4.39E-03
Infant	1.50E-05	2.32E-05	5.97E-04	0.00E+00	1.22E-05	1.94E-06	2.60E-05	4.39E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Ba-139								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.78E-03	2.69E-06	1.38E-04	0.00E+00	2.52E-06	4.62E-05	6.71E-03	6.76E-03
Teen	6.56E-03	4.61E-06	2.18E-04	0.00E+00	4.35E-06	8.00E-05	5.86E-02	6.76E-03
Child	1.61E-02	8.60E-06	4.95E-04	0.00E+00	7.51E-06	7.37E-05	9.31E-01	6.76E-03
Infant	1.76E-08	1.17E-11	2.75E-05	0.00E+00	7.04E-12	7.07E-05	6.06E-04	6.76E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Ba-140								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.09E-01	1.37E-04	3.60E-02	0.00E+00	4.67E-05	3.78E-02	2.29E-01	3.29E-02
Teen	1.19E-01	1.46E-04	3.65E-02	0.00E+00	4.94E-05	6.04E-02	1.88E-01	3.29E-02
Child	2.39E-01	2.10E-04	4.28E-02	0.00E+00	6.83E-05	5.18E-02	1.23E-01	3.29E-02
Infant	4.46E-02	4.46E-05	3.11E-02	0.00E+00	1.06E-05	4.74E-02	1.17E-02	3.29E-02

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Ba-141								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.83E-03	1.39E-06	2.01E-04	0.00E+00	1.29E-06	2.38E-05	8.66E-13	1.55E-03
Teen	3.16E-03	2.36E-06	2.45E-04	0.00E+00	2.19E-06	4.07E-05	6.75E-09	1.55E-03
Child	7.79E-03	4.36E-06	3.92E-04	0.00E+00	3.77E-06	6.03E-05	4.44E-03	1.55E-03
Infant	1.86E-09	1.28E-12	1.39E-04	0.00E+00	7.72E-13	3.53E-05	5.64E-05	1.55E-03

Dose factor - airborne release pathway (mrem/Ci released)								
La-140								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.17E-05	5.91E-06	2.70E-02	0.00E+00	0.00E+00	4.04E-03	6.96E-02	3.06E-02
Teen	1.57E-05	7.71E-06	2.70E-02	0.00E+00	0.00E+00	6.36E-03	5.51E-02	3.06E-02
Child	2.18E-05	7.60E-06	2.70E-02	0.00E+00	0.00E+00	5.42E-03	3.26E-02	3.06E-02
Infant	1.56E-05	6.17E-06	2.70E-02	0.00E+00	0.00E+00	4.98E-03	5.27E-03	3.06E-02

Dose factor - airborne release pathway (mrem/Ci released)								
La-142								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.98E-06	2.27E-06	1.97E-03	0.00E+00	0.00E+00	7.52E-05	1.65E-02	9.71E-03
Teen	8.44E-06	3.75E-06	1.97E-03	0.00E+00	0.00E+00	1.21E-04	1.14E-01	9.71E-03
Child	2.04E-05	6.50E-06	1.97E-03	0.00E+00	0.00E+00	1.03E-04	1.29E+00	9.71E-03
Infant	1.22E-08	4.48E-09	1.97E-03	0.00E+00	0.00E+00	9.77E-05	7.07E-04	9.71E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Ce-141								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	7.38E-04	5.01E-04	1.93E-02	0.00E+00	2.32E-04	1.07E-02	3.84E-01	2.16E-02
Teen	1.05E-03	7.02E-04	1.93E-02	0.00E+00	3.29E-04	1.82E-02	4.02E-01	2.16E-02
Child	1.65E-03	8.20E-04	1.93E-02	0.00E+00	3.59E-04	1.61E-02	3.02E-01	2.16E-02
Infant	8.32E-04	5.00E-04	1.92E-02	0.00E+00	1.58E-04	1.53E-02	3.79E-03	2.16E-02

Dose factor - airborne release pathway (mrem/Ci released)								
Ce-143								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	6.71E-05	4.80E-02	4.80E-03	0.00E+00	2.18E-05	9.48E-04	1.80E+00	6.60E-02
Teen	1.15E-04	8.10E-02	4.81E-03	0.00E+00	3.74E-05	1.55E-03	2.44E+00	6.60E-02
Child	2.77E-04	1.48E-01	4.82E-03	0.00E+00	6.31E-05	1.37E-03	2.17E+00	6.60E-02
Infant	3.55E-06	5.06E-05	4.80E-03	0.00E+00	6.85E-07	1.38E-03	8.73E-04	6.60E-02

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Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
Ce-144								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.26E-01	5.24E-02	1.04E-01	0.00E+00	3.10E-02	2.31E-01	8.05E+00	1.13E-01
Teen	1.83E-01	7.56E-02	1.07E-01	0.00E+00	4.51E-02	3.96E-01	9.46E+00	1.13E-01
Child	2.91E-01	9.10E-02	1.13E-01	0.00E+00	5.04E-02	3.55E-01	7.37E+00	1.13E-01
Infant	9.58E-02	3.64E-02	1.03E-01	0.00E+00	1.61E-02	2.92E-01	6.97E-02	1.13E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Pr-143								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	5.11E-04	2.05E-04	2.53E-05	0.00E+00	1.18E-04	3.34E-03	1.75E+00	3.77E-01
Teen	8.14E-04	3.25E-04	4.05E-05	0.00E+00	1.89E-04	5.74E-03	2.16E+00	3.77E-01
Child	1.82E-03	5.46E-04	9.02E-05	0.00E+00	2.96E-04	5.15E-03	1.73E+00	3.77E-01
Infant	1.67E-04	6.23E-05	8.32E-06	0.00E+00	2.35E-05	5.14E-03	5.83E-04	3.77E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Pr-144								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	8.93E-10	3.70E-10	2.58E-06	0.00E+00	2.09E-10	3.01E-05	6.39E-16	2.96E-06
Teen	1.27E-09	5.22E-10	2.58E-06	0.00E+00	2.99E-10	5.20E-05	6.98E-12	2.96E-06
Child	1.77E-09	5.48E-10	2.58E-06	0.00E+00	2.90E-10	4.64E-05	5.84E-06	2.96E-06
Infant	1.42E-09	5.48E-10	2.58E-06	0.00E+00	1.99E-10	4.78E-05	1.27E-04	2.96E-06

Dose factor - airborne release pathway (mrem/Ci released)								
Nd-147								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	8.95E-05	1.03E-04	2.00E-02	0.00E+00	6.04E-05	2.62E-03	1.51E-01	2.00E-01
Teen	1.22E-04	1.33E-04	2.00E-02	0.00E+00	7.80E-05	4.42E-03	1.15E-01	2.00E-01
Child	1.85E-04	1.49E-04	2.00E-02	0.00E+00	8.22E-05	3.90E-03	7.33E-02	2.00E-01
Infant	9.45E-05	9.69E-05	2.00E-02	0.00E+00	3.75E-05	3.83E-03	4.73E-04	2.00E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Eu-152								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.32E-02	2.45E-01	3.62E+01	0.00E+00	4.67E-02	3.26E-02	1.38E+00	6.86E+01
Teen	4.20E-02	1.02E-02	3.62E+01	0.00E+00	4.73E-02	4.76E-02	1.23E+00	6.86E+01
Child	6.02E-02	1.10E-02	3.62E+01	0.00E+00	4.64E-02	3.96E-02	8.25E-01	6.86E+01
Infant	1.30E-02	2.95E-03	3.62E+01	0.00E+00	9.90E-03	2.46E-02	5.31E-04	6.86E+01

Table 5.1-2

Dose factor - airborne release pathway (mrem/Ci released)								
W-187								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.08E-03	3.41E-03	7.22E-03	0.00E+00	0.00E+00	3.45E-04	1.12E+00	2.79E-02
Teen	6.98E-03	5.69E-03	8.03E-03	0.00E+00	0.00E+00	5.63E-04	1.54E+00	2.79E-02
Child	1.69E-02	1.00E-02	1.05E-02	0.00E+00	0.00E+00	4.88E-04	1.41E+00	2.79E-02
Infant	1.13E-05	7.88E-06	6.04E-03	0.00E+00	0.00E+00	4.71E-04	8.79E-04	2.79E-02

Dose factor - airborne release pathway (mrem/Ci released)								
U-235								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	4.06E+01	0.00E+00	1.04E+01	0.00E+00	9.47E+00	4.66E+00	3.87E+00	1.06E+01
Teen	6.45E+01	0.00E+00	1.19E+01	0.00E+00	1.51E+01	8.03E+00	4.59E+00	1.06E+01
Child	1.54E+02	0.00E+00	1.73E+01	0.00E+00	2.53E+01	7.17E+00	3.58E+00	1.06E+01
Infant	1.17E+01	0.00E+00	8.84E+00	0.00E+00	2.49E+00	5.46E+00	1.90E-01	1.06E+01

Dose factor - airborne release pathway (mrem/Ci released)								
U-238								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	3.88E+01	0.00E+00	2.33E+00	0.00E+00	8.86E+00	4.36E+00	2.72E+00	2.47E-01
Teen	6.17E+01	0.00E+00	3.70E+00	0.00E+00	1.41E+01	7.50E+00	3.23E+00	2.47E-01
Child	1.48E+02	0.00E+00	8.79E+00	0.00E+00	2.37E+01	6.73E+00	2.53E+00	2.47E-01
Infant	1.12E+01	0.00E+00	8.63E-01	0.00E+00	2.33E+00	5.09E+00	1.34E-01	2.47E-01

Dose factor - airborne release pathway (mrem/Ci released)								
Np-239								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	5.00E-05	4.92E-06	5.54E-03	0.00E+00	1.53E-05	4.47E-04	9.55E-01	9.52E-03
Teen	8.79E-05	8.29E-06	5.55E-03	0.00E+00	2.60E-05	7.71E-04	1.27E+00	9.52E-03
Child	2.11E-04	1.52E-05	5.55E-03	0.00E+00	4.39E-05	6.91E-04	1.10E+00	9.52E-03
Infant	4.42E-06	3.95E-07	5.54E-03	0.00E+00	7.88E-07	7.07E-04	3.14E-04	9.52E-03

Dose factor - airborne release pathway (mrem/Ci released)								
Am-241								
	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	1.34E+02	4.76E+01	1.03E+01	0.00E+00	6.70E+01	5.76E+00	3.48E+00	2.94E+00
Teen	1.46E+02	5.59E+01	1.11E+01	0.00E+00	7.31E+01	9.99E+00	4.12E+00	2.94E+00
Child	1.37E+02	6.14E+01	1.11E+01	0.00E+00	5.98E+01	8.88E+00	3.22E+00	2.94E+00
Infant	3.07E+01	1.41E+01	3.56E+00	0.00E+00	1.32E+01	6.76E+00	2.58E-03	2.94E+00

5.1.3 Atmospheric Release Mode: Noble Gases

The dose calculations for demonstration of compliance with the 10 CFR 50, Appendix I dose limits for noble gases released to the atmosphere will be done in the manner similar to the liquid release dose calculations described in Section 5.1.1. The total doses to the air, skin, and whole body resulting from the release of noble gases is compared to the corresponding Appendix limits. Noble gases released in liquids are to be added to the atmospherically released noble gases for Appendix I dose compliance calculations.

The doses are calculated using the following formula:

$$API = \Sigma\ Dose_{ti} = \Sigma\,(TDF_{ti} \times C_i) \leq K_t \text{ mrem}$$

where

API = the Appendix I dose for compliance evaluation in mrem

$Dose_{ti}$ = the dose to the applicable target (t) from radionuclide (i)

TDF_{ti} = total dose factor from Table 5.1-3 in mrem/Ci for the specific target (t) from radionuclide (i) based on the maximum annual average χ/Q at the site boundary

C_i = curies of radionuclide (i) released

K_t = the noble gas Appendix I dose limit for target (t)

The methodology used to obtain the TDF values are given in Appendix C.

Instead of using the precalculated total dose factors, the Appendix I dose calculation may be modified to reflect actual χ/Q values during the release using the methodology of Appendix C.

TABLE 5.1-3
ACTIVITY TO DOSE CONVERSION FACTORS FOR NOBLE GASES

(Highest Annual Average χ/Q)				
Nuclide	Beta Air (mrad/Ci)	Gamma Air (mrad/Ci)	Skin (mrem/Ci)	Whole Body (mrem/Ci)
AR-41	1.56E-04	4.42E-04	6.19E-04	4.20E-04
KR-83M	1.37E-05	9.18E-07	1.02E-06	3.59E-09
KR-85M	9.37E-05	5.85E-05	1.34E-04	5.56E-05
KR-85	9.27E-05	8.18E-07	6.46E-05	7.66E-07
KR-87	4.90E-04	2.93E-04	7.88E-04	2.81E-04
KR-88	1.39E-04	7.23E-04	9.15E-04	6.99E-04
KR-89	5.04E-04	8.23E-04	1.39E-03	7.89E-04
KR-90	3.72E-04	7.75E-04	1.21E-03	7.42E-04
XE-131M	5.28E-05	7.42E-06	3.09E-05	4.35E-06
XE-133M	7.04E-05	1.55E-05	6.45E-05	1.19E-05
XE-133	4.99E-05	1.68E-05	3.32E-05	1.40E-05
XE-135M	3.51E-05	1.60E-04	2.11E-04	1.48E-04
XE-135	1.17E-04	9.13E-05	1.90E-04	8.61E-05
XE-137	6.04E-04	7.18E-05	6.60E-04	6.75E-05
XE-138	2.26E-04	4.38E-04	6.82E-04	4.20E-04

6.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Technical Specification 5.5.1.b requires the ODCM to contain the radiological environmental monitoring activities. A complete description of the PBNP radiological environmental monitoring program, including procedures and responsibilities, is contained in the PBNP Environmental Manual. The latter is hereby incorporated into the Offsite Dose Calculation Manual (ODCM) by reference.

7.0 RADIOLOGICAL EFFLUENT CONTROLS PROGRAM

Technical Specifications 5.5.1.b and 5.5.4 require the ODCM to contain the radiological effluent controls program. A complete description of the PBNP radiological effluent controls program is contained in the PBNP Radiological Effluent Control Manual. The latter is hereby incorporated in the ODCM by reference.

8.0 RADIOLOGICAL IMPACT EVALUATION OF SEWAGE TREATMENT SLUDGE DISPOSAL

The methodology for determining the radiological impact of contaminated sewage treatment sludge is presented in this section. The evaluation must be made prior to every land application of sewage treatment plant (STP) sludge that contains licensed material. Sludge and other STP material which does not contain licensed materials may be disposed of by any legal method without prior radiological analysis.

8.1 Basis, Commitments, and Actions

8.1.1 Basis

With the discovery that the PBNP STP sludge contained licensed material, Wisconsin Electric applied for NRC approval to dispose of the sludge by land application on land within the PBNP site boundary pursuant to 10 CFR 20.302(a). Wisconsin Electric committed to gamma isotopic analysis (GIA) of the sludge to measure the concentrations of licensed material in the STP sludge and to compare the results to concentration limits prior to each disposal [letter dated October 8, 1987 (VPNPD-87-430, NRC-87-104)]. In addition, the dose to the maximally exposed individual of the general public and to the inadvertent intruder would be evaluated for the appropriate exposure pathways.

8.1.2 Basis for NRC Commitment Modification

Pursuant to NRC guidance, the sludge is clean if no licensed materials are found when analyzed under conditions necessary to achieve the environmental LLDs (NRC HPPOS 221). Clean sludge is not under NRC jurisdiction and may be disposed of by any legal method without prior radioanalyses. Therefore, if the sludge is clean and there is no pathway to the STP from the RCA, or pathways are administratively controlled to prevent the transfer of licensed materials to the STP, there is no need to analyze the sludge prior to any disposal.

Since the 1987 commitment, engineering modifications and administrative controls have eliminated the pathways from the RCA to the STP. Three subsequent sludge GIAs (a total of eight STP samples) utilizing the analytical parameters required to achieve environmental lower limit of detection (LLD) found only naturally occurring radionuclides. In each analysis, the licensed materials were below the minimum detectable activity for the particular measurement and below the required LLDs. These results verify the efficiency of the modifications and administrative controls in eliminating pathways from the RCA to the STP. Therefore, because there is no longer any reason to believe that the PBNP STP sewage contains licensed material and there are no pathways from the RCA to the STP, the sewage may be disposed of by any legal method without GIA prior to each disposal.

8.1.3 Modification

Periodic gamma isotopic analyses (GIA) of the STP sludge shall occur at a frequency set forth in the Chemistry Analytical Methods & Procedures (CAMP). This may include analyses prior to disposal depending on the results from the periodic analyses. The GIA of the STP sludge shall meet the LLD criteria of normal liquid effluents. The detection of any licensed material in the sludge during the periodic GIA shall necessitate returning to the GIA prior to disposal in order to evaluate the radiological consequences of the disposal. The GIA prior to each disposal shall continue until such time that the sludge can be shown, using environmental LLD criteria, not to contain licensed material.

Also, re-initiation of the 1987 commitment to analyze the STP sludge prior to each disposal shall be required if plant conditions change in a manner which would lead one to believe that the STP sludge may be contaminated. An example of such a condition is the opening of valve STP-009 which is controlled by a danger tag. Again, reversion to a CAMP controlled frequency can occur only upon verification that no licensed material is in the sludge pursuant to the environmental LLD criteria.

8.1.4 Exposure Evaluations

If the sludge contains licensed material, the 1987 commitment requires that the appropriate exposure pathways be evaluated prior to each application of sludge to insure that the dose to the maximally exposed member of the general public is maintained at less than 1 mrem/year and that to the inadvertent intruder, at less than 5 mrem/year. Also, the measured concentration shall be compared to the liquid maximum effluent concentrations of Appendix B to 10 CFR 20.

The exposure pathways evaluated for the maximally exposed individual are the following:

1. External whole body exposure due to a ground plane source of radionuclides.

2. Milk ingestion pathway from cows fed alfalfa grown on plot.

3. Meat ingestion pathway from cows fed alfalfa grown on plot.

4. Vegetable ingestion pathway from vegetables grown on plot.

5. Inhalation of radioactivity resuspended in air above plot.

6. Pathways associated with a release to Lake Michigan. These pathways are ingestion of potable water at the Two Rivers, Wisconsin municipal water supply, ingestion of fish from edge of initial mixing zone of radionuclide release, ingestion of fresh and stored vegetables irrigated with water from Lake Michigan, ingestion of milk and meat from cows utilizing Lake Michigan as drinking water source, swimming and boating activities at the edge of the initial mixing zone, and shoreline deposits.

The exposure pathways evaluated for the inadvertent intruder are the same as items 1, 4, 5, and 6 identified above for the maximally exposed individual.

8.2 Procedure

The following steps are to be performed by the responsible Radiological Engineer for each contaminated sewage treatment sludge disposal:

8.2.1 Obtain from PBNP-Chemistry the radionuclide concentrations in each representative sewage treatment sludge sample. The minimum number of representative samples required is three from each sludge storage tank. The average of all statistically valid concentration determinations will be utilized in determining the sludge storage tank concentration values.

8.2.2 Verify that the concentration of each radionuclide meets the concentration and activity limit criteria. The methodology for determining compliance with the concentration and activity limit criteria are contained in Wisconsin Electric letter VPNPD 87-430.

8.2.3 Verify that the proposed disposal of the sewage treatment sludge will maintain doses within the applicable limits. This calculation will include radionuclides disposed of in previous sludge applications. The activity from these prior disposals will be corrected for radiological decay prior to performing dose calculations for the meat, milk, and vegetable ingestion pathways, the inhalation of resuspended radionuclides, and all pathways associated with a potential release to Lake Michigan. The residual radioactivity will be corrected, if applicable, for the mixing of radionuclides in the soil prior to performing external exposure calculations.

Wisconsin Electric utilizes QAD, a nationally recognized computer code, to perform shielding and dose rate analyses. QAD will be used to calculate the dose rate due to standing on a plot of land utilized for sludge disposal in which the radionuclides from prior disposals have been incorporated into the plot by plowing. This calculated dose rate will be used to assess the radiological consequences from prior disposals with the consequences of proposed future disposals. The total radiological dose consequence of the past and the proposed disposal will be compared to the applicable limits to insure the dose is maintained at or below the limits.

The methodology for calculating the radiological impact of the sewage treatment sludge disposal is contained in Wisconsin Electric letter VPNPD 87-430.

8.2.4 Inform PBNP - Chemistry that the sewage treatment sludge disposal may proceed after verifying that the sewage treatment sludge meets the concentration, activity, and dose limits.

8.2.5 Forward all calculations to PBNP - Chemistry to be included with the sewage treatment sludge disposal record.

8.3 Administrative Requirements

8.3.1 Complete records of each contaminated disposal shall be kept as follows:

a. Radionuclide concentration of the sludge.

b. Total volume of sludge disposed.

c. The identity of the plot used for the disposal.

d. Dose calculation results.

e. Results of annual chemical composition determination.

8.3.2 Modifications to the WE application as documented in the October 8, 1987, letter shall be processed in accordance with NP 5.1.7, "Regulatory Commitment Management." (CCE 2001-013)

a. Commitment Change -1

Section 3.2 of Attachment II of the submittal states that physical and chemical properties of the sludge would be determined prior the each land application. Pursuant to a change in the PBNP WPDES Permit, non-radiological properties are now determined annually instead of per application. The frequency for radiological characterization did not change. (See CCE 2002-002)

b. Commitment Change -2

In Section 3.3 of Attachment II of the submittal letter, the annual disposal rate was..." limited to 4,000 gallons/acre, provided WDNR chemical composition, NRC dose guidelines and activity limits are maintained...." Modification 2 removes the 4,000 gallon limit and makes the application unlimited provided the WDNR and NRC constraints are met. (See CCE 2002-004)

c. Commitment Change -3

In Section 3.2 of Attachment II of NRC submittal letter dated October 8, 1987, Wisconsin Electric committed to gamma isotopic analysis (GIA) to determine the concentration of licensed material in sewage treatment plant (STP) sludge prior to each disposal. Pursuant to NRC HPPOS-221 guidance, the sludge has been shown to be clean on three different occasions after pathways from the RCA to the STP were eliminated by plant modifications and administrative controls. Pursuant to HPPOS, the sludge analyses were done under the conditions necessary to achieve the environmental LLDs. Only naturally occurring radionuclides were found and licensed material was below the minimum detectable concentration. This indicates that the former pathways from the RCA to the STP had been eliminated. Therefore, there is not need to continue the analyses because there is no RCA to STP pathway and there is no reason to believe that the sewage contains licensed material. Hence, the commitment to analyze STP sludge prior to every disposal is modified and replaced with periodic analyses at a frequency set by CAMP 914. However, if plant conditions change in a manner which places the STP sewage outside the guidance parameters which allowed for the discontinuance of analyses, the sewage must be analyzed prior to each disposal until it again is shown not to contain licensed material. (See CCE-2002-3)

APPENDIX A

DERIVATION OF LIQUID RELEASE PATHWAY

EFFECTIVE MAXIMUM EFFLUENT CONCENTRATION

A.1.0 Derivation of Liquid Release Effective Maximum Effluent Concentration

A.1.1 Source Term

The effective maximum effluent concentration is calculated from the annual releases via liquids for the years 1985-1991 (Table A-1). Although Na-24 was discharged in 1985, it was excluded from the isotopic mixture because it is not a radionuclide which would be normally found in PBNP effluent. Na-24 appears in the effluent because it was used for tests run on the steam system. Tritium also was omitted from the initial calculation because its production is largely independent from the appearance of the fission products in the effluent.

A.1.2 Effective Maximum Effluent Concentration

The effective maximum effluent concentration (EMEC) was calculated using the formula given in Section 3.6

$$EMEC = \Sigma C_i \ / \ \Sigma (C_i/MEC_i) \text{ or } \Sigma C_i * 1/SOF$$

where:

SOF = $\Sigma C_i/MEC_i$ is the summation of fractions for the annual effluent isotopic release

C_i = concentration of radionuclide "i" (µCi/ml) in effluent (annual discharge/total volume of discharge)

MEC_i = maximum effluent concentration for unrestricted areas from Appendix B, Table 2, Column 2 of the revised 10 CFR 20.

The SOF for radionuclides in liquid effluent for the years 1985 through 1991 were calculated with and without H-3 and used to calculate the EMEC for the same years (Table B-2). The average EMEC without H-3 is 4.29E-06 µCi/cc. This is the maximum concentration of non H-3 radionuclides in a mixture that could be released in liquid effluent without the SOF exceeding one (1).

However, the 10 CFR 20 Appendix B criterion is that the SOF for all radionuclides, including H-3 which can not be measured by the liquid effluent NaI RMS monitors, be less than or equal to one (1). Therefore, the above equation, modified by a factor of 0.70 to account for H-3, becomes

$$EMEC = 0.70\,\Sigma C_i \ / \ \Sigma (C_i/MEC_i) \text{ or } \Sigma C_i * 0.70/SOF.$$

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The EMEC becomes

EMEC = 0.70 * 4.29E-06 = 3.00E-06 μCi/cc.

Only three radionuclides identified in PBNP liquid effluent have a lower MEC (10 CFR 20, Appendix B, Table 2). They are I-131 (1E-06), Cs-134 (9E-07), and Cs-137 (1E-06).

By restricting the non-tritium radionuclides to 70% of their calculated EMEC, the H-3 concentration can be discharged at 30% of its MEC or 3.00E-04 μCi/cc without exceeding the SOF criterion of 10 CFR 20, Appendix B for the total liquid effluent isotopic mixture.

TABLE A-1
CURIES RELEASED IN LIQUIDS

LIQUID RELEASES								
NUCLIDE	MEC uCi/cc	1985	1986	1987	1988	1989	1990	1991
H-3	1.00E-03	8.05E+02	8.11E+02	7.09E+02	3.57E+02	5.59E+02	8.72E+02	7.87E+02
I-131	1.00E-06	1.02E-01	3.74E-02	1.04E-02	1.40E-03	1.77E-03	1.53E-04	1.83E-03
I-132	1.00E-04	6.15E-02	7.25E-02	5.82E-02	1.03E-03	8.15E-04	4.45E-05	9.41E-03
I-133	7.00E-06	1.27E-01	1.49E-01	1.04E-01	1.21E-02	8.11E-03	3.01E-03	1.01E-02
I-134	4.00E-04	3.18E-02	4.39E-02	3.97E-02	2.29E-04	6.83E-04		
I-135	3.00E-05	1.04E-01	1.34E-01	1.23E-01	4.48E-04	8.21E-04		
AG-110M	6.00E-06	2.55E-05	2.84E-04	3.09E-03	9.85E-04	4.70E-04	1.71E-04	4.06E-04
BA-133	2.00E-05							
BA-139	2.00E-04			8.63E-06	2.47E-04			
BA-140	8.00E-06	6.90E-06		4.45E-05	6.13E-05			
CD-109	6.00E-06		6.33E-05	1.31E-04				
CE-139	7.00E-05							
CE-141	3.00E-05	1.31E-03		7.50E-04				
CE-144	3.00E-06		1.37E-03	2.08E-03	4.76E-04	1.59E-04	9.47E-06	9.64E-06
CO-56	6.00E-06							
CO-57	6.00E-05	2.52E-03	1.33E-04	3.21E-04	5.07E-05	6.90E-07	4.08E-06	
CO-58	2.00E-05	4.05E-01	9.02E-03	3.36E-02	6.81E-03	3.12E-03	3.25E-04	2.93E-03
CO-60	3.00E-06	2.88E-01	2.85E-02	6.34E-02	2.04E-02	1.54E-02	1.41E-03	5.53E-03
CR-51	5.00E-04	2.71E-02	3.16E-04	1.58E-02	5.31E-05	4.44E-04	8.71E-05	
CS-134	9.00E-07	4.76E-02	6.92E-03	1.18E-03	4.96E-04			1.49E-03
CS-134M	2.00E-03				3.59E-04	5.97E-06		4.67E-04
CS-136	6.00E-06							
CS-137	1.00E-06	9.60E-02	2.11E-02	7.54E-03	8.63E-03	2.80E-03	1.94E-03	8.93E-03
CS-138	4.00E-04	1.11E-03	5.48E-03	3.24E-03				
F-18	7.00E-04		1.00E-02	1.67E-02	7.56E-04	1.66E-03	2.26E-03	4.06E-04
FE-59	1.00E-05			2.76E-04				
LA-140	9.00E-06							
MN-54	3.00E-05	7.46E-03	1.18E-03	4.68E-03	1.54E-04	2.68E-04	3.10E-05	1.96E-04
MO-99	2.00E-05				3.70E-05			
NB-95	3.00E-05	6.28E-03	6.65E-04	3.21E-03	1.61E-04	2.33E-06	8.68E-05	
NB-97	3.00E-04	1.35E-03	5.22E-04	6.16E-05	1.06E-05	3.90E-06	8.80E-06	5.30E-06
RB-88	4.00E-04	8.46E-05	1.11E-02	3.33E-03				
RB-89	9.00E-04		7.98E-04	2.34E-04				
RU-103	3.00E-05	3.59E-03	1.68E-06	8.41E-04	5.86E-05			
RU-106	3.00E-06	8.07E-04	2.88E-03	7.33E-03	1.04E-04			
SB-124	7.00E-06	3.86E-02	2.96E-04	1.42E-04	2.34E-04			
SB-125	3.00E-05	1.12E-02	1.20E-03	1.95E-03	1.00E-03	2.12E-02	1.28E-05	1.08E-02
SN-113	3.00E-05	1.07E-03	4.20E-05	5.13E-04	3.21E-04			3.07E-06
SR-89	8.00E-06	2.27E-04	3.46E-05	3.89E-03	2.68E-03	8.69E-06		
SR-90	5.00E-07	1.29E-03	2.28E-04	2.80E-04	3.50E-04	2.55E-04		
TC-99M	1.00E-03	1.75E-05	3.75E-06		3.30E-05			
TC-101	2.00E-03			1.10E-05				
TE-131	8.00E-05				7.98E-05			
TE-132	9.00E-06	5.83E-07	6.94E-05	2.74E-05	7.19E-06			1.74E-04
W-187	3.00E-05				3.41E-05			
Y-91M	2.00E-03							
ZN-65	5.00E-06			5.15E-05				
ZR-95	2.00E-05	7.95E-05	2.61E-04	2.45E-03		1.58E-05		
ZR-97	9.00E-06	1.49E-06	3.09E-06		1.74E-05			
TOTAL CI		8.06E+02	8.12E+02	7.10E+02	3.57E+02	5.59E+02	8.72E+02	7.87E+02
TOTAL W/O H-3		1.37E+00	5.39E-01	5.12E-01	5.99E-02	5.65E-02	9.57E-03	5.42E-02

TABLE A-2
FRACTIONAL MEC IN LIQUID EFFLUENT

NUCLIDE	MEC uCi/cc	1985	1986	1987	1988	1989	1990	1991
H-3	1.00E-03	1.27E-03	1.25E-03	1.04E-03	5.17E-04	8.36E-04	1.26E-03	1.22E-03
I-131	1.00E-06	1.61E-04	5.75E-05	1.52E-05	2.03E-06	2.65E-06	2.21E-07	2.84E-06
I-132	1.00E-04	9.70E-07	1.12E-06	8.53E-07	1.49E-08	1.22E-08	6.43E-10	1.46E-07
I-133	7.00E-06	2.86E-05	3.27E-05	2.18E-05	2.51E-06	1.73E-06	6.21E-07	2.24E-06
I-134	4.00E-04	1.25E-07	1.69E-07	1.46E-07	8.30E-10			2.65E-09
I-135	3.00E-05	5.47E-06	6.87E-06	6.01E-06	2.16E-08			4.24E-08
AG-110M	6.00E-06	6.70E-09	7.28E-08	7.55E-07	2.38E-07	1.17E-07	4.12E-08	1.05E-07
BA-133	2.00E-05							
BA-139	2.00E-04			6.33E-11	1.79E-09			
BA-140	8.00E-06	1.36E-09	0.00E+00	8.16E-09	1.11E-08			
CD-109	6.00E-06		1.62E-08		3.16E-08			
CE-139	7.00E-05							
CE-141	3.00E-05	6.89E-08		3.67E-08				
CE-144	3.00E-06		7.03E-07	1.02E-06	2.30E-07	7.92E-08	4.56E-09	4.98E-09
CO-56	6.00E-06							
CO-57	6.00E-05	6.62E-08	3.41E-09	7.84E-09	1.22E-09	1.72E-11	9.83E-11	
CO-58	2.00E-05	3.19E-05	6.94E-07	2.46E-06	4.93E-07	2.33E-07	2.35E-08	2.27E-07
CO-60	3.00E-06	1.51E-04	1.46E-05	3.10E-05	9.86E-06	7.67E-06	6.79E-07	2.86E-06
CR-51	5.00E-04	8.55E-08	9.72E-10	4.63E-08	1.54E-10	1.33E-09	2.52E-10	
CS-134	9.00E-07	8.34E-05	1.18E-05	1.92E-06	7.99E-07			2.57E-06
CS-134M	2.00E-03				2.60E-10	4.46E-12		3.62E-10
CS-136	6.00E-06							
CS-137	1.00E-06	1.51E-04	3.25E-05	1.11E-05	1.25E-05	4.19E-06	2.80E-06	1.38E-05
CS-138	4.00E-04	4.38E-09	2.11E-08	1.19E-08				
F-18	7.00E-04		2.20E-08	3.50E-08	1.57E-09	3.54E-09	4.67E-09	8.99E-10
FE-59	1.00E-05			4.05E-08				
LA-140	9.00E-06							
MN-54	3.00E-05	3.92E-07	6.05E-08	2.29E-07	7.44E-09	1.34E-08	1.49E-09	1.01E-08
M0-99	2.00E-05				2.68E-09			
NB-95	3.00E-05	3.30E-07	3.41E-08	1.57E-07	7.78E-09	1.16E-10	4.18E-09	
NB-97	3.00E-04	7.10E-09	2.68E-09	3.01E-10	5.12E-11	1.94E-11	4.24E-11	2.74E-11
RB-88	4.00E-04	3.34E-10	4.27E-08	1.22E-08				
RB-89	9.00E-04		1.36E-09	3.81E-10				
RU-103	3.00E-05	1.89E-07	8.62E-11	4.11E-08	2.83E-09			
RU-106	3.00E-06	4.24E-07	1.48E-06	3.58E-06	5.02E-08			
SB-124	7.00E-06	8.70E-06	6.51E-08	2.97E-08	4.84E-08			
SB-125	3.00E-05	5.89E-07	6.15E-08	9.53E-08	4.83E-08	1.06E-06	6.17E-10	5.58E-07
SN-113	3.00E-05	5.63E-08	2.15E-09	2.51E-08	1.55E-08			1.59E-10
SR-89	8.00E-06	4.48E-08	6.65E-09	7.13E-07	4.86E-07	1.62E-09		
SR-90	5.00E-07	4.07E-06	7.02E-07	8.21E-07	1.01E-06	7.62E-07		
TC-99M	1.00E-03	2.76E-11	5.77E-12		4.78E-11			
TC-101	2.00E-03			8.06E-12				
TE-131	8.00E-05				1.45E-09			
TE-132	9.00E-06	1.02E-10	1.19E-08	4.46E-09	1.16E-09			3.00E-08
W-187	3.00E-05				1.65E-09			
Y-91M	2.00E-03							
ZN-65	5.00E-06			1.51E-08				
ZR-95	2.00E-05	6.27E-09	2.01E-08	1.80E-07			1.14E-09	
ZR-97	9.00E-06	2.61E-10	5.28E-10		2.80E-09			

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TABLE A-2, (cont.)
FRACTIONAL MEC IN LIQUID EFFLUENT

	1985	1986	1987	1988	1989	1990	1991
ANNUAL VOL(CCs)	6.34E+14	6.50E+14	6.82E+14	6.90E+14	6.69E+14	6.92E+14	6.45E+14
TOT FRACTION	1.90E-03	1.41E-03	1.14E-03	5.48E-04	8.54E-04	1.26E-03	1.25E-03
FRACT W/O H-3	6.29E-04	1.61E-04	9.83E-05	3.04E-05	1.85E-05	4.41E-06	2.55E-05
TOTAL CI	8.06E+02	8.12E+02	7.10E+02	3.57E+02	5.59E+02	8.72E+02	7.87E+02
TOTAL W/O H-3	1.37E+00	5.39E-01	5.12E-01	5.99E-02	5.65E-02	9.57E-03	5.42E-02
TOT CONC(uCi/CC)	1.27E-06	1.25E-06	1.04E-06	5.17E-07	8.36E-07	1.26E-06	1.22E-06
TCON W/O H-3	2.16E-09	8.30E-10	7.51E-10	8.69E-11	8.44E-11	1.38E-11	8.40E-11
EMEC	6.70E-04	8.86E-04	9.14E-04	9.45E-04	9.78E-04	9.97E-04	9.80E-04
EMEC W/O H-3	3.43E-06	5.14E-06	7.64E-06	2.85E-06	4.56E-06	3.14E-06	3.30E-06

APPENDIX B

DERIVATION OF ATMOSPHERIC RELEASE MODE

EFFECTIVE MAXIMUM EFFLUENT CONCENTRATION

B.1.0 Derivation of Atmospheric Release Effective Maximum Effluent Concentration

B1.1 Source Term

The effective maximum effluent concentration (EMEC) for atmospheric effluents is calculated from the annual releases for the years 1985-1991 (Table B-1). Unlike liquid releases, tritium was not omitted from the EMEC calculation. Instead, the EMEC was calculated with H-3 and then modified by the fraction of non-tritium radionuclides in the effluent.

B1.2 Effective Maximum Effluent Concentration

The maximum concentration of a radionuclide mixture that is allowable at the site boundary is called the effective maximum effluent concentration (EMEC). The EMEC for an effluent mixture is defined by the equation

$$EMEC = \Sigma C_i \ / \ \Sigma(C_i \ / \ MEC_i)$$

where

C_i = concentration of radionuclide "i"

MEC_i = maximum effluent concentration for radionuclide "i" from 10 CFR 20, Appendix B, Table 2, Column 1

$\Sigma (C_i \ / \ MEC_i)$ = summation of fractions (SOF), as discussed in Section 3.6, applied to atmospheric releases

The EMEC is calculated from the reference radionuclide mixture which is the radionuclides released during the years 1985 - 1991. The average annual site boundary concentration for each year was calculated using the highest annual average χ/Q of 1.56E-06 sec/m^3. Then the total EMEC was calculated for each year (Table C-2). The average total EMEC is 8.04E-08±1.31E-08 µCi/cc with a range of 5.84E-08 to 9.50E-08 µCi/cc. Next, the annual EMEC was modified for the presence of H-3, which is not detected by the atmospheric RMS, by multiplying each EMEC by the ratio of the non H-3 concentration to the total concentration. The annual H-3 corrected EMECs were averaged to obtain a value of 1.92E-08±1.23E-08 µCi/cc with a range of 5.02E-09 to 3.70E-08 µCi/cc.

TABLE B-1
CURIES IN ATMOSPHERIC EFFLUENT

NUCLIDE	MEC uCi/ml	1985	1986	1987	1988	1989	1990	1991
H-3	1.00E-07	6.71E+01	1.20E+02	1.18E+02	1.26E+02	1.42E+02	1.28E+02	1.13E+02
AR-41	1.00E-08	1.27E+00	6.81E-01	2.17E+00	1.96E+00	1.57E+00	1.11E+00	1.07E+00
KR-85M	1.00E-07	1.84E+01	6.77E-01	1.18E+00	7.31E-01	2.24E-01	1.85E-01	1.03E-01
KR-85	7.00E-07	1.67E+01	1.32E+00	7.11E-01	9.84E-01	3.58E-01	1.78E-01	2.74E-01
KR-87	2.00E-08	4.78E+00	1.01E+00	2.37E+00	1.48E+00	4.94E-01	4.05E-01	2.31E-01
KR-88	9.00E-09	5.73E+00	1.30E+00	2.72E+00	1.69E+00	5.64E-01	4.49E-01	2.56E-01
XE-131M	2.00E-06	8.54E-02						
XE-133M	6.00E-07	3.30E-01	1.38E-01	2.12E-01	3.35E-01	4.94E-03	2.06E-02	3.97E-02
XE-133	5.00E-07	3.45E+01	1.53E+01	2.06E+01	6.04E+01	7.54E+00	1.96E+00	1.60E+01
XE-135M	4.00E-08	5.76E+00	1.27E+00	3.68E+00	2.54E+00	7.37E-01	6.49E-01	3.44E-01
XE-135	7.00E-08	1.19E+01	3.21E+00	5.64E+00	3.53E+00	1.08E+00	1.09E+00	6.03E-01
XE-138	2.00E-08	1.65E+01	2.91E+00	8.87E+00	7.19E+00	2.45E+00	1.99E+00	1.06E+00
AG-110M	1.00E-10				2.31E-07			
BA-133	9.00E-10							
BA-139	4.00E-08							1.17E-07
BA-140	2.00E-09			3.41E-07				
CD-109	2.00E-10	8.92E-06	1.26E-06	2.28E-04				
CE-139	9.00E-10							
CE-141	8.00E-10	8.48E-09						
CE-144	2.00E-11		2.04E-06			3.92E-07		3.94E-09
CO-57	9.00E-10	2.10E-07		2.52E-11	1.13E-08		1.23E-06	4.80E-07
CO-58	1.00E-09	1.57E-04	1.33E-05	1.01E-04	3.59E-05	1.69E-04	2.74E-05	3.85E-06
CO-60	5.00E-11	7.94E-05	1.11E-04	1.18E-05	3.64E-04	1.63E-04	3.56E-06	1.06E-04
CR-51	3.00E-08					5.28E-04		7.58E-09
CS-134	2.00E-10	1.18E-03	9.49E-04	5.86E-05	7.27E-05			1.10E-03
CS-136	9.00E-10							
CS-137	2.00E-10	4.02E-03	2.94E-04	3.08E-04	6.74E-04	2.10E-03	1.91E-04	1.90E-03
CS-138	8.00E-08	9.64E-07	1.92E-06	1.85E-03	1.26E-07	3.44E-06		1.92E-02
F-18	1.00E-07		1.08E-05	2.52E-04	3.87E-05	3.31E-04	1.10E-05	6.60E-04
FE-59	7.00E-10							4.87E-09
MN-54	1.00E-09	1.99E-06	1.70E-06		4.86E-05			
M0-99	2.00E-09			7.27E-09	2.71E-08			
NA-24	7.00E-09	1.39E-04		4.32E-04	4.29E-04			
NB-95	2.00E-09	2.52E-06	7.70E-07	5.97E-07	6.25E-08		9.56E-10	
NB-97	1.00E-07				1.60E-08			1.65E-09
RB-88	9.00E-08	4.63E-05	3.46E-05	1.03E-02	4.00E-06	1.81E-05		1.62E-01
RB-89	2.00E-07					4.30E-09		
RU-103	9.00E-10	1.91E-08	1.89E-05					
SB-125	7.00E-10	1.25E-07		3.68E-06	9.39E-08			
SN-113	8.00E-10	2.16E-08			4.80E-10			
SR-89	2.00E-10	4.87E-08	1.54E-06	7.70E-07	3.71E-06			
SR-90	6.00E-12			1.68E-10	4.30E-06			
SR-91	5.00E-09							
TC-99M	3.00E-07			6.43E-08	2.20E-07	9.24E-07		
TC-101	5.00E-07							
TE-132	9.00E-10				3.07E-06	7.33E-08		2.34E-06
Y-88	3.00E-10			1.28E-10				
ZN-65	4.00E-10				9.27E-06			
ZR-95	4.00E-10	1.31E-06			3.56E-09		7.43E-10	
ZR-97	2.00E-09	2.97E-10						

TABLE B-1, (cont.)
CURIES IN ATMOSPHERIC EFFLUENT

NUCLIDE	MEC uCi/ml	1985	1986	1987	1988	1989	1990	1991
I-131	2.00E-10	3.44E-03	1.11E-03	3.08E-03	5.43E-04	3.18E-04	7.85E-05	3.46E-04
I-132	2.00E-08	3.75E-03	1.79E-03	2.42E-03	4.78E-04	4.20E-05	1.09E-05	2.95E-05
I-133	1.00E-09	1.37E-03	6.80E-04	3.04E-03	1.53E-03	1.19E-03	1.13E-04	1.13E-04
I-134	6.00E-08	1.33E-05		9.32E-04				
I-135	6.00E-09	5.79E-04	1.09E-04	2.19E-03	9.18E-05	1.26E-05	3.15E-08	1.58E-05

TABLE B-2
FRACTIONAL MEC FOR ATMOSPHERIC EFFLUENT

NUCLIDE	1985	1986	1987	1988	1989	1990	1991
H-3	3.20E-05	5.71E-05	5.62E-05	6.00E-05	6.76E-05	6.10E-05	5.38E-05
AR-41	6.05E-06	3.24E-06	1.03E-05	9.33E-06	7.48E-06	5.29E-06	5.10E-06
KR-85M	8.76E-06	3.22E-07	5.62E-07	3.48E-07	1.07E-07	8.81E-08	4.90E-08
KR-85	1.14E-06	8.98E-08	4.84E-08	6.69E-08	2.44E-08	1.21E-08	1.86E-08
KR-87	1.14E-05	2.40E-06	5.64E-06	3.52E-06	1.18E-06	9.64E-07	5.50E-07
KR-88	3.03E-05	6.88E-06	1.44E-05	8.94E-06	2.98E-06	2.38E-06	1.35E-06
XE-131M	2.03E-09						
XE-133M	2.62E-08	1.10E-08	1.68E-08	2.66E-08	3.92E-10	1.63E-09	3.15E-09
XE-133	3.29E-06	1.46E-06	1.96E-06	5.75E-06	7.18E-07	1.87E-07	1.52E-06
XE-135M	6.86E-06	1.51E-06	4.38E-06	3.02E-06	8.77E-07	7.73E-07	4.10E-07
XE-135	8.10E-06	2.18E-06	3.84E-06	2.40E-06	7.35E-07	7.41E-07	4.10E-07
XE-138	3.93E-05	6.93E-06	2.11E-05	1.71E-05	5.83E-06	4.74E-06	2.52E-06
AG-110M				1.10E-10			
BA-139							1.39E-13
BA-140			8.12E-12				
CD-109	2.12E-09	3.00E-10	5.43E-08				
CE-141	5.05E-13						
CE-144		4.86E-09			9.33E-10		9.38E-12
CO-57	1.11E-11		1.33E-15	5.98E-13		6.51E-11	2.54E-11
CO-58	7.48E-09	6.33E-10	4.81E-09	1.71E-09	8.05E-09	1.30E-09	1.83E-10
CO-60	7.56E-08	1.06E-07	1.12E-08	3.47E-07	1.55E-07	3.39E-09	1.01E-07
CR-51					8.38E-10		1.20E-14
CS-134	2.81E-07	2.26E-07	1.40E-08	1.73E-08			2.62E-07
CS-136							
CS-137	9.57E-07	7.00E-08	7.33E-08	1.60E-07	5.00E-07	4.55E-08	4.52E-07
CS-138	5.74E-13	1.14E-12	1.10E-09	7.50E-14	2.05E-12		1.14E-08
F-18		5.14E-12	1.20E-10	1.84E-11	1.58E-10	5.24E-12	3.14E-10
FE-59							3.31E-13
MN-54	9.48E-11	8.10E-11		2.31E-09			
M0-99			1.73E-13	6.45E-13			
NA-24	9.46E-10		2.94E-09	2.92E-09			
NB-95	6.00E-11	1.83E-11	1.42E-11	1.49E-12		2.28E-14	
NB-97				7.62E-15			7.86E-16
RB-88	2.45E-11	1.83E-11	5.45E-09	2.12E-12	9.58E-12		8.57E-08
RB-89					1.02E-15		
RU-103	1.01E-12	1.00E-09					
SB-125	8.50E-12		2.50E-10	6.39E-12			
SN-113	1.29E-12			2.86E-14			
SR-89	1.16E-11	3.67E-10	1.83E-10	8.83E-10			
SR-90			1.33E-12	3.41E-08			
SR-91							
TC-99M			1.02E-14	3.49E-14	1.47E-13		
TC-101							
TE-132				1.62E-10	3.88E-12		1.24E-10
Y-88			2.03E-14				
ZN-65				1.10E-09			
ZR-95	1.56E-10			4.24E-13		8.85E-14	
ZR-97	7.07E-15						

TABLE B-2, (cont.)
FRACTIONAL MEC FOR ATMOSPHERIC EFFLUENT

NUCLIDE	1985	1986	1987	1988	1989	1990	1991
I-131	8.19E-07	2.64E-07	7.33E-07	1.29E-07	7.57E-08	1.87E-08	8.24E-08
I-132	8.93E-09	4.26E-09	5.76E-09	1.14E-09	1.00E-10	2.60E-11	7.02E-11
I-133	6.52E-08	3.24E-08	1.45E-07	7.29E-08	5.67E-08	5.38E-09	5.38E-09
I-134	1.06E-11		7.40E-10				
I-135	4.60E-09	8.65E-10	1.74E-08	7.29E-10	1.00E-10	2.50E-13	1.25E-10
TOTALFRAC	1.49E-04	8.29E-05	1.20E-04	1.11E-04	8.83E-05	7.62E-05	6.67E-05
TOTAL-H3	1.17E-04	2.57E-05	6.34E-05	5.13E-05	2.07E-05	1.52E-05	1.29E-05
EFF MEC	5.84E-08	8.49E-08	6.62E-08	8.85E-08	8.46E-08	8.50E-08	9.50E-08
W/O H-3	3.70E-08	1.60E-08	1.92E-08	3.46E-08	8.10E-09	5.02E-09	1.44E-08

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APPENDIX C

CALCULATION OF TOTAL DOSE FACTORS

USING

REGULATORY GUIDE 1.109, REV. 1

C.1.0 Calculation of Total Dose Factors Using Regulatory Guide 1.109 Methodology

C.1.1 Liquid Release Dose Factors

The equations and values used to calculate the total dose to the maximum exposed individual for each of the liquid release mode pathways evaluated according to Regulatory Guide 1.109, Rev. 1, 1977 methodology is shown below. The total dose factor in mrem/Ci released is the sum of all pathway doses in mrem/Ci for the following pathways: milk, meat, fish, potable water, and shoreline deposits. The results for an organ is summed for each pathway and the total presented by age group and target organ in a matrix format for each radionuclide in Section 5, Table 5.1.1. The derivation of dilution factors used in the calculations is presented in Appendix D. The highest dose in each matrix is used as the dose tracking factor to be used for the monthly tracking of release doses. These values are found in Section 5, Table 5.2.

Note that all of the liquid release dose calculations assume that the discharge rate is 677,000 gpm. Whenever the average discharge rate for the month or year differs, the final dose calculated must be multiplied by the correction factor CF where:

CF = 677,000 gpm / actual average discharge gpm

This correction will produce a greater change during the winter months when the circ water flow rates are lower.

C1.1.1 Aquatic Foods

The dose from the eating of fresh fish caught at the edge of the initial mixing zone was calculated using the equation:

$$\text{Dose}_{apj} = 1100\frac{M_p U_{ap}}{F}\sum_i Q_i B_{ip} D_{aipj} e^{-\lambda_i t_p}$$

where:

$Dose_{apj}$ = the dose to the organ j of an individual of age group a from all of the nuclides i in pathway p, in mrem/year;

1100 = a factor to convert from Ci-sec/yr-ft^3 to pCi/liter;

M_p = the mixing ratio (reciprocal of the dilution factor) at the point of harvest of aquatic food, dimensionless;

U_{ap} = a usage factor that specifies the intake rate for an individual of age group a associated with pathway p, in kg/year;

F = the flow rate of the liquid effluent, in ft^3/sec;

Q_i = the release rate of nuclide i, in Ci/year;

B_{ip} = the equilibrium bioaccumulation factor for nuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the radionuclide concentration in water (in pCi/l), in liters/kg;

D_{aipj} = the dose factor, specific to a given age group a, nuclide i, pathway p, and organ j, which is used to calculate the radiation dose from an intake of a nuclide, in mrem/pCi;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_p = the average transit time required for nuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclides and the ingestion of the water, in days.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{aipj}}{Q_i} = 1100 \frac{M_p U_{ap}}{F} B_{ip} D_{aipj} e^{-\lambda_i t_p}$$

The values used in the equation above are:

M_p = 0.1136 (Point of harvest of the fresh fish is taken at a point 1000 m downstream. The plume centerline dilution factor at this location is 8.8 using RG 1.111 methodology. The dilution factor calculations are attached. The factor of 2 allowed for current reversals was not used.);

U_{ap} = Infant - 0, Child - 6.9, Teen - 16, and Adult - 21 kg/year;

F = 1507 ft^3/sec. (677000 gpm);

B_{ip} = Values used are taken from Table A-1 of RG 1.109;

D_{aipj} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_p = 0.5 days.

C1.1.2 Irrigated Foods (Meat From Watered Cattle)

The dose from the ingestion of meat from cattle which have been given contaminated water was calculated using the equation:

$$Dose_{apj} = 1100 \frac{M_p U_{ap} Q_{Aw}}{F} \sum_i Q_i F_{iA} D_{aipj} e^{-\lambda_i t_p}$$

where:

$Dose_{apj}$ = the dose to the organ j of an individual of age group a from all of the nuclides i in pathway p, in mrem/year;

1100 = factor to convert from Ci-sec/yr-ft^3 to pCi/liter;

U_{ap} = a usage factor that specifies the intake rate for an individual of age group a associated with pathway p, in kg/year;

M_p = the mixing ratio (reciprocal of the dilution factor) at the point of exposure, dimensionless;

Q_{Aw} = consumption rate of contaminated water by an animal, in liters/day;

F = the flow rate of the liquid effluent, in ft^3/sec;

Q_i = the release rate of nuclide i, in Ci/year;

F_{iA} = the stable element transfer coefficient that relates the daily intake rate by an animal to the concentration in an edible portion of animal product, in pCi/liter of meat per pCi/day;

D_{aipj} = the dose factor, specific to a given age group a, nuclide i, pathway p, and organ j, which is used to calculate the radiation dose from an intake of a nuclide, in mrem/pCi;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_s = the average time from slaughter to consumption, in days.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{aipj}}{Q_i} = 1100\frac{M_p U_{ap} Q_{Aw}}{F} F_{iA} D_{aipj} e^{-\lambda_i t_s}$$

The values used in the equation above are:

M_p = 0.1111 (Point at which water is taken from the lake is taken as plume centerline 1 mile downstream. The plume centerline dilution factor at this location is 9 using RG 1.111 methodology.);

U_{ap} = Infant - 0, Child - 41, Teen - 65, and Adult - 110 kg/year;

Q_{Aw} = 60 liters/day;

F = 1507 ft^3/sec. (677000 gpm);

F_{iA} = Values used are taken from Table E-1 of RG 1.109;

D_{aipj} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_s = 20 days.

C1.1.3 Irrigated Foods (Milk From Watered Cattle)

The dose from the ingestion of milk from cows which have been given contaminated water was calculated using the equation:

$$Dose_{apj} = 1100 \frac{M_p U_{ap} Q_{Aw}}{F} \sum_i Q_i F_{iA} D_{aipj} e^{-\lambda_i t_f}$$

where:

$Dose_{apj}$ = the dose to the organ j of an individual of age group a from all of the nuclides i in pathway p, in mrem/year;

1100 = factor to convert from Ci-sec/yr-ft^3 to pCi/liter;

M_p = the mixing ratio (reciprocal of the dilution factor) at the point of exposure, dimensionless;

U_{ap} = a usage factor that specifies the intake rate for an individual of age group a associated with pathway p, in liters/year;

Q_{Aw} = consumption rate of contaminated water by an animal, in liters/day;

F = the flow rate of the liquid effluent, in ft^3/sec;

Q_i = the release rate of nuclide i, in Ci/year;

F_{iA} = the stable element transfer coefficient that relates the daily intake rate by an animal to the concentration in an edible portion of animal product, in pCi/liter of milk per pCi/day;

D_{aipj} = the dose factor, specific to a given age group a, nuclide i, pathway p, and organ j, which is used to calculate the radiation dose from an intake of a nuclide, in mrem/pCi;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_f = the average transport time of the activity from the feed into the milk and to the receptor, in days.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{aipj}}{Q_i} = 1100\frac{M_p U_{ap} Q_{Aw}}{F} F_{iA} D_{aipj} e^{-\lambda_i t_f}$$

The values used in the equation above are:

M_p = 0.1111 (Point at which water is taken from the lake is taken as plume centerline 1 mile downstream. The plume centerline dilution factor at this location is 9 using RG 1.111 methodology. the dilution factor calculations are attached. The factor of 2 allowed for current reversals was not used. This is a conservative assumption.);

U_{ap} = Infant - 330, Child - 330, Teen - 400, and Adult - 310 liters/year;

Q_{Aw} = 60 liters/day;

F = 1507 ft^3/sec. (677000 gpm);

F_{iA} = Values used are taken from Table E-1 of RG 1.109;

D_{aipj} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_f = 2 days.

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C1.1.4 Potable Water

The dose from ingestion of water was calculated using the equation:

$$Dose_{apj} = 1100 \frac{M_p U_{ap}}{F} \sum_i Q_i D_{aipj} e^{-\lambda_i t_p}$$

where:

$Dose_{apj}$	=	the dose to the organ j of an individual of age group a from all of the nuclides i in pathway p, in mrem/year;
1100	=	a factor to convert from Ci-sec/yr-ft^3 to pCi/liter;
M_p	=	the mixing ratio (reciprocal of the dilution factor) at the point of withdrawal of drinking water, dimensionless;
U_{ap}	=	a usage factor that specifies the intake rate for an individual of age group a associated with pathway p, in l/year;
F	=	the flow rate of the liquid effluent, in ft^3/sec;
Q_i	=	the release rate of nuclide i, in Ci/year;
D_{aipj}	=	the dose factor, specific to a given age group a, nuclide i, pathway p, and organ j, which is used to calculate the radiation dose from an intake of a nuclide, in mrem/pCi;
λ_i	=	the radioactive decay constant of nuclide i, in day^{-1};
t_p	=	the average transit time required for nuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclides and the ingestion of the water, in days.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{aipj}}{Q_i} = 1100 \frac{M_p U_{ap}}{F} D_{aipj} e^{-\lambda_i t_p}$$

The values used in the equation above are:

M_p = 0.0384 (Withdrawal point is taken as the Two Rivers municipal water intake located a distance of 12 miles downstream. The plume centerline dilution factor at this location is 26 using RG 1.111 methodology and the factor of 2 allowed for current reversals. The dilution factor calculations are attached.);

U_{ap} = Infant - 330, Child - 510, Teen - 510, and Adult - 730 liters/year;

F = 1507 ft^3/sec. (677000 gpm);

D_{aipj} = Values used are taken from Tables E-11 through E-14 of RG 1.109

t_p = 2 days (This was calculated using a current speed of 12.2 cm/s plus 12 hours to reflect the transport of the water through the water purification plant and distribution system.)

C1.1.5 Shoreline Deposits

The dose from exposure to radioactive materials deposited on the shoreline of the lake was calculated using the equation:

$$Dose_{apj} = 110000 \frac{M_p U_{ap} W}{F} \sum_i Q_i T_i D_{aipj} e^{-\lambda_i t_p} \left(1 - e^{-\lambda_i t_b}\right)$$

where:

$Dose_{apj}$ = the dose to the organ j of an individual of age group a from all of the nuclides i in pathway p, in mrem/year;

110000 = a factor to convert from Ci-sec/yr-ft^3 to pCi/liter and to account for the proportionality constant used in the sediment radioactivity model;

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M_p = the mixing ratio (reciprocal of the dilution factor) at the point of exposure, dimensionless;

U_{ap} = a usage factor that specifies the exposure time for an individual of age group a associated with pathway p, in hours/year;

W = shoreline width factor, dimensionless;

F = the flow rate of the liquid effluent, in ft^3/sec;

Q_i = the release rate of nuclide i, in Ci/year;

T_i = the radioactive half life of nuclide i, in days;

D_{aipj} = the dose factor, specific to a given age group a, nuclide i, pathway p, and organ j, which is used to calculate the radiation dose from an intake of a nuclide, in mrem/pCi;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_p = the average transit time required for nuclides to reach the point of exposure. For internal dose, t_p is the total time elapsed between release of the nuclides and the ingestion of the water, in days;

t_b = the period of time for which the sediment or soil is exposed to the contaminated water, in days.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{aipj}}{Q_i} = 110000 \frac{M_p U_{ap} W}{F} B_{ip} T_i D_{aipj} e^{-\lambda_i t_p} \left(1 - e^{-\lambda_i t_b}\right)$$

The values used in the equation above are:

M_p = 0.01821 (Point of exposure is taken as the Point Beach State Park beach which is located 8000 meters downstream. The plume shoreline dilution factor at this location is 54.9 using RG 1.111 methodology. The dilution factor calculations are attached. The factor of 2 allowed for current reversals was not used.);

U_{ap} = Infant - 0, Child - 14, Teen - 67, and Adult - 12 hours/year;

W = 0.3;

B_{ip} = Values used are taken from Table A-1 of RG 1.109;

F = 1507 ft^3/sec. (677000 gpm);

D_{aipj} = Values used are taken from Table E-6 of RG 1.109;

t_p = 0.5 day;

t_b = 5458 days.

C1.2 Atmospheric Release Dose Factors: Non-Gaseous

The equations and values used to calculate the total dose to the maximum exposed individual factors for non-gaseous radionuclides released to the atmosphere using Regulatory Guide 1.109, Rev. 1, 1977 is shown below. The total dose factor in mrem/Ci released is the sum of all airborne effluent doses in mrem/Ci for the following pathways: milk, meat, leafy vegetables, potable water, and shoreline deposits. A summary of totals is presented by age group and target organ in matrix format for each radionuclide in Section 5, Table 5-1. The highest dose in each matrix is used as the dose tracking factor to be used for the monthly tracking of release doses. These values are found in Section 5, Table 5-2.

Note that Section C1.2.1 applies to both tritium and particulates. Sections C1.2.2 through C1.2.6 apply only to particulates released to the atmosphere. Atmospheric tritium releases are treated differently. Sections C1.2.7 through C1.2.10 apply to tritium.

C1.2.1 Inhalation of Nuclides In Air

The dose from the inhalation of nuclides in the air was calculated using the equation:

$$Dose_{ja} = 3.17E{+}04 R_a \left(\frac{\chi}{Q}\right) \sum_i Q_i DFI_{ija}$$

where:

$Dose_{ja}$ = the annual dose to organ j of an individual of age group a due to inhalation, in mrem/year;

3.17E+04 = the number of pCi/Ci divided by the number of sec/year;

R_a = the annual air intake for individuals in the age group a, in m^3/year;

χ/Q = the annual average atmosphere dispersion factor, in sec/m^3 (The location at which the dose was calculated was the site boundary in the south sector - a distance of 1270 meters.);

Q_i = the release rate of nuclide i, in Ci/year;

DFI_{ija} = the inhalation dose factor for radionuclide i, organ j, and age group a, mrem/pCi.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ija}}{Q_i} = 3.17E+04\, R_a \left(\frac{\chi}{Q}\right) DFI_{ija}$$

The values used in the equation above are:

R_a = Infant - 1400, Child - 3700, Teen - 8000, and Adult - 8000 m^3/year;

χ/Q = 9.36E-07 seconds/m^3 (This value taken from Table I.4-2 of the FSAR, release mode 1B, annual average, site boundary.);

DFI_{ija} = Values used are taken from Tables E-7 through E-10 of RG 1.109.

C1.2.2 <u>Annual Organ Dose From External Irradiation From Nuclides Deposited On the Ground</u>

The organ dose from external irradiation from nuclides deposited on the ground was calculated using the equation:

$$Dose_j = 1E+12\,(8760)\,\delta_i\, S_F \sum_i \frac{Q_i\left(1-e^{-\lambda_i t_b}\right)}{\lambda_i} DFG_{ij}$$

where:

$Dose_j$ = the annual dose to the organ j, in mrem/year;

1E+12 = the number of pCi per Ci;

8760 = the number of hours in a year;

δ_i = the annual average relative deposition of nuclide i, considering depletion of the plume during transport, in m^{-2}, (The location at which the dose is calculated is the site boundary in the south sector - a distance of 1300 meters.);

S_F = the attenuation factor that accounts for the dose reduction due to shielding provided by residential structures, dimensionless;

Q_i = the release rate of nuclide i, in Ci/year;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_b = the time period over which the accumulation is evaluated, in days;

DFG_{ij} = the open field ground plane dose conversion factor for organ j from nuclide i, in mrem-m^2/pCi-hour.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ij}}{Q_i} = 1E+12\,(8760)\,\delta_i\,S_F\frac{\left(1-e^{-\lambda_i t_b}\right)}{\lambda_i}DFG_{ij}$$

The values used in the equation above are:

δ_i = 31E-09 m^{-2} (This value taken from Table I.4-2 of the FSAR, release mode 1B, annual average, site boundary.);

S_F = 1 (No structural shielding is assumed.);

t_b = 5479 days (15 years);

DFG_{ij} = Values used are taken from Table E-6 of RG 1.109.

C1.2.3 Annual Organ Dose From Atmospherically Released Nuclides In Milk

The organ dose from atmospherically released nuclides in milk was calculated using the equation:

$$Dose_{ja} = 2.7E+09\, U_a Q_F \delta_i \sum_i Q_i F_{im} DFI_{ija} e^{-\lambda_i t_f} \left\{ f_p f_s + e^{-90\lambda_i}\left(1 - f_p f_s\right)\right\}$$
$$\times \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_v \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

where:

$Dose_{ja}$ = the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides, in mrem/year;

2.7E+09* = the number of pCi per Ci divided by the number of days per year;

U_a = the ingestion rate of milk for individuals in age group a, in liters/year;

Q_F = the amount of feed consumed by a cow per, in kg/day;

δ_i = the annual average relative deposition of nuclide i, considering depletion of the plume during transport, in m^{-2}, (The location at which the dose is calculated is the nearest animal location in the south-southeast sector - a distance of 1300 meters.);

Q_i = the release rate of nuclide i, in Ci/year;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_b = the time period over which the accumulation is evaluated, in days;

DFI_{ija} = the dose conversion factor for the ingestion of nuclide i, organ j, and age group a, in mrem/pCi;

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F_{im} = the average fraction of the animal's daily intake of nuclide i which appears in each liter of milk, in days/liter;

t_f = the average transport time of the activity from the feed into the milk and to the receptor, in days;

f_p = the fraction of the year that the animals graze on pasture, dimensionless;

f_s = the fraction of the daily feed that is pasture grass when the animal grazes on pasture, dimensionless;

r = the fraction of the deposited activity retained on crops, dimensionless;

λ_{Ei} = the effective removal rate constant for nuclide i from crops, in $days^{-1}$, where $\lambda_{Ei} = \lambda_i + \lambda_w$, and λ_w is the removal rate constant for physical loss by weathering;

λ_w = $0.0504\ day^{-1}$;

t_e = the time period that crops are exposed to contamination during the growing season, in days;

Y_V = the agricultural productivity, in kg (wet weight)/m^2;

B_{iv} = the concentration factor for the uptake of nuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the nuclide concentration in water (in pCi/liter), in liters/kg;

P = the effective surface density for soil, in kg (dry soil)/m^2.

* For iodines, this factor is changed to 1.4E+09.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ija}}{Q_i} = 2.7E{+}9\, U_a Q_F \delta_i \sum_i F_{im} DFI_{ija} e^{-\lambda_i t_f} \left\{ f_p f_s + e^{-90\lambda_i}\left(1 - f_p f_s\right)\right\}$$
$$\times \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_V \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

The values used in the equation above are:

U_a = Infant - 330, Child - 330, Teen - 400, and Adult - 310 liters/year;

Q_F = 50 kg/day;

δ_i = 18.8E-09 m^{-2} (This value taken from Table I.4-2 of the FSAR, release mode 1B, grazing season, site boundary.);

F_{im} = Values used are taken from Table E-1 of RG 1.109;

DFI_{ija} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_f = 2 days;

f_p = 0.5;

f_s = 0.5;

r = 0.25, 1.0 for iodines, and 0.20 for noble gases, tritium, and carbon-14;

t_e = 30 days;

Y_V = 0.7 kg/m^2;

B_{iv} = Values used are taken from Table E-1 of RG 1.109;

P = 240 kg/m^2;

t_b = 5458 days (15 years).

C1.2.4 Annual Organ Dose From Atmospherically Released Nuclides In Meat

The organ dose from atmospherically released nuclides in meat was calculated using the equation:

$$Dose_{ja} = 2.7E+9\, U_a Q_F \delta_i \sum_i Q_i F_{if} DFI_{ija} e^{-\lambda_i t_s} \left\{ f_p f_s + e^{-90\lambda_i}\left(1 - f_p f_s\right)\right\}$$
$$\times \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_v \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

where:

$Dose_{ja}$	=	the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides, in mrem/year;
2.7E+9*	=	the number of pCi per Ci divided by the number of days per year;
U_a	=	the ingestion rate of meat for individuals in age group a, in liters/year;
Q_F	=	the amount of feed consumed by a cow per, in kg/day;
δ_i	=	the annual average relative deposition of nuclide i, considering depletion of the plume during transport, in m^{-2}, (The location at which the dose is calculated is the nearest animal location in the south-southeast sector - a distance of 1300 meters.);
Q_i	=	the release rate of nuclide i, in Ci/year;
λ_i	=	the radioactive decay constant of nuclide i, in day^{-1};
t_b	=	the time period over which the accumulation is evaluated, in days;
DFI_{ija}	=	the dose conversion factor for the ingestion of nuclide i, organ j, and age group a, in mrem/pCi;

F_{if} = the average fraction of the animal's daily intake of nuclide i which appears in each kilogram of flesh, in days/kg;

t_s = the average time from slaughter to consumption, in days;

f_p = the fraction of the year that the animals graze on pasture, dimensionless;

f_s = the fraction of the daily feed that is pasture grass when the animal grazes on pasture, dimensionless;

r = the fraction of the deposited activity retained on crops, dimensionless;

λ_{Ei} = the effective removal rate constant for nuclide i from crops, in days^{-1}, where $\lambda_{Ei} = \lambda_i + \lambda_w$, and λ_w is the removal rate constant for physical loss by weathering;

t_e = the time period that crops are exposed to contamination during the growing season, in days;

Y_V = the agricultural productivity, in kg (wet weight)/m^2;

B_{iv} = the concentration factor for the uptake of nuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the nuclide concentration in water (in pCi/liter), in liters/kg;

P = the effective surface density for soil, in kg (dry soil)/m^2.

* For iodines, this factor is changed to 1.4E+09.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ija}}{Q_i} = 2.7E{+}9\, U_a Q_F \delta_i \sum_i F_{if}\, DFI_{ija}\, e^{-\lambda_i t_s} \left\{ f_p f_s + e^{-90\lambda_i}\left(1 - f_p f_s\right)\right\}$$
$$\times \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_V \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

The values used in the equation above are:

U_a = Infant - 0, Child - 41, Teen - 65, and Adult - 110 kg/year;

Q_F = 50 kg/day;

δ_i = 18.8E-09 m^{-2} (This value taken from Table I.4-2 of the FSAR, release mode 1B, grazing season, site boundary.);

F_{if} = Values used are taken from Table E-1 of RG 1.109;

DFI_{ija} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_s = 20 days;

f_p = 0.5;

f_s = 1.0;

r = 0.25, 1.0 for iodines, and 0.20 for noble gases, tritium, and carbon-14;

t_e = 30 days;

B_{iv} = Values used are taken from Table E-1 of RG 1.109;

Y_V = 0.7 kg/m^2;

P = 240 kg/m^2;

λ_w = 0.0504 day^{-1};

t_b = 5458 days (15 years).

C1.2.5 Annual Organ Dose From Atmospherically Released Nuclides In Produce

The organ dose from atmospherically released nuclides in produce was calculated using the equation:

$$Dose_{ja} = 2.7E+9\, U_a f_g \delta_i \sum_i Q_i DFI_{ija} e^{-\lambda_i t_h} \left\{ \frac{r\left(1 - e^{-\lambda_E t_e}\right)}{Y_v \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

where:

$Dose_{ja}$ = the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides, in mrem/year;

2.7E+9* = the number of pCi per Ci divided by the number of days per year;

U_a = the ingestion rate of produce for individuals in age group a, in kg/year;

f_g = fraction of produce ingested grown in garden of interest, dimensionless;

δ_i = the annual average relative deposition of nuclide i, considering depletion of the plume during transport, in m^{-2}, (The location at which the dose is calculated is the nearest garden location in the south-southwest sector - a distance of 1460 meters.);

Q_i = the release rate of nuclide i, in Ci/year;

λ_i = the radioactive decay constant of nuclide i, in day^{-1};

t_b = the time period over which the accumulation is evaluated, in days;

DFI_{ija} = the dose conversion factor for the ingestion of nuclide i, organ j, and age group a, in mrem/pCi;

t_h = the holdup time that represents the time interval between harvest and consumption of the food, in days;

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r = the fraction of the deposited activity retained on crops, dimensionless;

λ_{Ei} = the effective removal rate constant for nuclide i from crops, in days^{-1}, where $\lambda_{Ei} = \lambda_i + \lambda_w$, and λ_w is the removal rate constant for physical loss by weathering;

t_e = the time period that crops are exposed to contamination during the growing season, in days;

Y_V = the agricultural productivity, in kg (wet weight)/m^2;

B_{iv} = the concentration factor for the uptake of nuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the nuclide concentration in water (in pCi/liter), in liters/kg;

P = the effective surface density for soil, in kg (dry soil)/m^2.

* For iodines, this factor is changed to 1.4E+09.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ija}}{Q_i} = 2.7E+9\, U_a f_g \delta_i \sum_i DFI_{ija} e^{-\lambda_i t_h} \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y v \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

The values used in the equation above are:

U_a = Infant - 0, Child - 520, Teen - 630, and Adult - 520 kg/year;

f_g = 0.76;

δ_i = 18.8E-09 m^{-2} (This value taken from Table I.4-2 of the FSAR, release mode 1B, growing season, site boundary.);

DFI_{ija} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_h = 60 days;

r = 0.25, 1.0 for iodines, and 0.20 for noble gases, tritium, and carbon-14;

λ_w = 0.0504 day^{-1};

t_e = 60 days;

Y = 0.7 kg/m^2;

B_{iv} = Values used are taken from Table E-1 of RG 1.109;

P = 240 kg/m^2;

t_b = 5458 days (15 years).

C1.2.6 Annual Organ Dose From Atmospherically Released Nuclides In Leafy Vegetables

The organ dose from atmospherically released nuclides in leafy vegetables was calculated using the equation:

$$Dose_{ja} = 2.7E+9\, U_a f_l \delta_i \sum_i Q_i DFI_{ija} e^{-\lambda_i t_h} \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_v \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

where:

$Dose_{ja}$	=	the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides, in mrem/year;
2.7E+9*	=	the number of pCi per Ci divided by the number of days per year;
U_a	=	the ingestion rate of produce for individuals in age group a, in kg/year;
f_l	=	fraction of leafy vegetables ingested grown in garden of interest, dimensionless;
δ_i	=	the annual average relative deposition of nuclide i, considering depletion of the plume during transport, in m^{-2}, (The location at which the dose is calculated is the nearest garden location in the south-southwest sector - a distance of 1460 meters.);
Q_i	=	the release rate of nuclide i, in Ci/year;
λ_i	=	the radioactive decay constant of nuclide i, in day^{-1};
t_b	=	the time period over which the accumulation is evaluated, in days;
DFI_{ija}	=	the dose conversion factor for the ingestion of nuclide i, organ j, and age group a, in mrem/pCi;
t_h	=	the holdup time that represents the time interval between harvest and consumption of the food, in days;

r = the fraction of the deposited activity retained on crops, dimensionless;

λ_{Ei} = the effective removal rate constant for nuclide i from crops, in days^{-1}, where $\lambda_{Ei} = \lambda_i + \lambda_w$, and λ_w is the removal rate constant for physical loss by weathering;

t_e = the time period that crops are exposed to contamination during the growing season, in days;

Y_V = the agricultural productivity, in kg (wet weight)/m^2;

B_{iv} = the concentration factor for the uptake of nuclide i in pathway p, expressed as the ratio of the concentration in biota (in pCi/kg) to the nuclide concentration in water (in pCi/liter), in liters/kg;

P = the effective surface density for soil, in kg (dry soil)/m^2.

* For iodines, this factor is changed to 1.4E+09.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_{ija}}{Q_i} = 2.7E+9\, U_a f_l \delta_i \sum_i DFI_{ija}\, e^{-\lambda_i t_h} \left\{ \frac{r\left(1 - e^{-\lambda_{Ei} t_e}\right)}{Y_V \lambda_{Ei}} + \frac{B_{iv}\left(1 - e^{-\lambda_i t_b}\right)}{P \lambda_i} \right\}$$

The values used in the equation above are:

U_a = Infant - 0, Child - 26, Teen - 42, and Adult - 64 kg/year;

f_l = 1;

δ_i = 18.8E-09 m^{-2} (This value taken from Table I.4-2 of the FSAR, release mode 1B, growing season, site boundary.);

DFI_{ija} = Values used are taken from Tables E-11 through E-14 of RG 1.109;

t_h = 1 day;

r = 0.25, 1.0 for iodines, and 0.20 for noble gases, tritium, and carbon-14;

λ_w = 0.0504 day^{-1};

t_e = 60 days;

Y_V = 0.7 kg/m^2;

B_{iv} = Values used are taken from Table E-1 of RG 1.109;

P = 240 kg/m^2;

t_b = 5458 days (15 years).

C1.2.7 Doses from Airborne Tritium other than Inhalation

The calculation methodology for doses from airborne H-3 via the meat, milk and vegetation pathways is different from that of particulates because tritium is a vapor and not a particle. The concentrations of tritium in vegetation are based on the concentrations found in the air surrounding the vegetation; and, all other vegetation based pathway doses are calculated from this quantity. The concentration in vegetation (forage, produce and leafy vegetables) is calculated from the formula (Reg. Guide 1.109, Rev. 1, p.1.109-27):

$$C_{tv} = 3.17E{+}07\ Q_T[\chi/Q](0.75)(0.5/H)$$

where:

Q_T = annual release rate of tritium in Ci/year;

$[\chi/Q]$ = annual average atmosphere dispersion factor, in sec/m^3 (The location at which the dose was calculated was the site boundary in the south sector, a distance of 1270m);

3.17E+07 = (1.0E+12 pCi/Ci) (1.0E+03 g/Kg) / (3.15E+07 sec/yr)

0.75 = fraction of plant mass which is water;

0.5 = fraction of concentration of tritium in plant water to concentration of tritium in atmospheric water;

H = absolute humidity of atmosphere in g/m^3

Inserting the following values into the formula:

$[\chi/Q]$ = 9.36E-07 sec/m^3 (from Table I.4-2 of the FSAR, release mode 1B, annual average site boundary);

H = 5.5 g/m^3 (from E. L. Entier (1980), Health Physics 39:318-320).

yields

$$C_{tv} = 2.0230\ Q_T$$

which then is used to calculate doses from leafy vegetables and produce as well as from milk and meat results for cattle ingestion of vegetation with the H-3 concentration.

C1.2.8 Annual Organ Dose from Atmospherically Released Tritium in Produce

Concentrations of tritium in vegetation are based on its concentration in the air surrounding the vegetation as defined above in C1.2.7. The doses are calculated using the equation:

$$Dose_{ja} = DFI_{ja} U_a f_g C_{tv}$$

where:

$Dose_{ja}$ = the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides in mrem/yr;

DFI_{ja} = the dose conversion factor for the ingestion of tritium in organ j and age group a in mrem/yr;

U_a = ingestion rate for produce for individuals in age group a;

f_g = fraction of produce ingested;

C_{tv} = concentration of tritium in vegetation, defined as 2.023 Q_T.

To calculate the dose per curie released, the equation above is rearranged and the calculation performed. The rearranged equation is shown below:

$$\frac{Dose_{ja}}{Q_T} = 2.023\ DFI_{ja}U_a f_g$$

The values used in the equation above are:

DFI_{ja} = values taken from Tables E-11 through E-14 of RG 1.109;

U_a = Infant-0, Child-520, Teen-630, Adult-520;

f_g = 0.76;

C1.2.9 Annual Organ Dose from Atmospherically Released Tritium in Milk

The organ dose is calculated using the equation:

$$Dose_{ja} = DFI_{ja}U_aC_{tm}$$

where C_{tm} is the concentration of tritium in milk which is calculated using the formula:

$$C_{tm} = F_mC_{tv}Q_F\exp(-\lambda_t t_f).$$

Substituting C_{tm} into the dose formula, the following equation results:

$$Dose_{ja} = DFI_{ja}U_aF_mC_{tv}Q_F\exp(-\lambda_t t_f)$$

where:

$Dose_{ja}$ = the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides in mrem/yr;

DFI_{ja} = the dose conversion factor for the ingestion of tritium in organ j and age group a in mrem/yr;

U_a = ingestion rate for produce for individuals in age group a;

F_m = average fraction of animal's daily intake of tritium which appears in milk (days/liter);

C_{tv} = concentration of tritium in animal's feed (since the formula for the concentration of tritium in vegetation does not depend on time, there is no distinction made between pasture grass and stored feeds);

Q_F = amount of feed consumed by animal per day;

t_f = average transport time from feed into milk and to receptor;

λ_t = radiological decay constant for tritium.

To calculate the dose per curie released, the equation above is rearranged and the calculation performed. The rearranged equation is shown below:

$$\frac{Dose_{ja}}{Q_T} = 2.023\ DFI_{ja} U_a F_m Q_F \exp(-\lambda_t t_f)$$

The values used in the above equation are:

DFI_{ja} = values taken from Tables E-11 through E-14 of RG 1.109;

U_a = Infant-330, Child-330, Teen-400, Adult-310;

F_m = 1.0E-02 days/liter (from RG 1.109 Table E-1);

C_{tv} = 2.0230 Q_T pCi/g;

Q_F = 50 kg/day;

t_f = 2 days;

λ_t = 0.000154 $days^{-1}$.

C1.2.10 Annual Organ Dose from Atmospherically Released Tritium in Meat

The organ dose is calculated using the equation:

$$Dose_{ja} = DFI_{ja} U_a C_{tf}$$

where C_{tf} is defined as the concentration of tritium in meat which is calculated using the formula:

$$C_{tf} = F_f C_{tv} Q_F \exp(-\lambda_t t_s)$$

When this is inserted into the dose formula, the following equation results:

$$Dose_{ja} = DFI_{ja} U_a F_f C_{tv} Q_F \exp(-\lambda_t t_s)$$

where:

$Dose_{ja}$ = the annual dose to the organ j of an individual in age group a from a dietary intake of atmospherically released nuclides in mrem/yr;

DFI_{ja} = the dose conversion factor for the ingestion of tritium in organ j and age group a in mrem/yr;

U_a = ingestion rate for produce for individuals in age group a;

F_f = fraction of animal's daily intake of tritium which appears in each kilogram of flesh (days/kg);

C_{tv} = concentration of tritium in animal's feed (since the formula for the concentration of tritium in vegetation does not depend on time, there is no distinction made between pasture grass and stored feeds);

Q_F = amount of feed consumed by animal per day;

t_s = average time from slaughter to consumption;

λ_t = radiological decay constant for tritium.

To calculate the dose per curie released, the equation above is rearranged and the calculation performed. The rearranged equation is shown below:

$$\frac{Dose_{ja}}{Q_T} = 2.023\ DFI_{ja} U_a F_f Q_F \exp(-\lambda_t t_s)$$

The values used in the equation above are:

DFI_{ja} = values taken from Tables E-11 through E-14 of RG 1.109;

U_a = Infant-0, Child-41, Teen-65, Adult-110;

F_f = 1.2E-02 days/kg;

C_{tv} = 2.0230 Q_T pCi/g;

Q_F = 50 kg/day;

t_s = 20 days;

λ_t = 0.000154 $days^{-1}$.

C1.3 Atmospheric Release Dose Factors: Noble Gases

The equations and values used to calculate the total dose factors for noble gases released to the atmosphere using Regulatory Guide 1.109, Rev. 1, 1977 is shown below. The dose factor in mrem/Ci and mrad/Ci released for each radionuclide is presented in Section 5, Table 5-1.

C1.3.1 Annual Gamma and Beta Air Dose From All Noble Gas Releases

The dose from the submersion of individuals in air containing noble gases was calculated using the equation:

$$\text{Dose}^{\gamma} \text{ or } \text{Dose}^{\beta} = 3.17\text{E}+04\left(\frac{\chi}{Q}\right)\sum_i Q_i\left(DF_i^{\gamma} \text{ or } DF_i^{\beta}\right)$$

where:

Dose^{γ} or Dose^{β}	=	the annual gamma and beta air dose, in mrad/year;
3.17E+04	=	the number of pCi/Ci divided by the number of sec/year;
χ/Q	=	the annual average atmosphere dispersion factor, in sec/m^3 (The location at which the dose was calculated was the site boundary in the south sector-a distance of 1270 meters.);
Q_i	=	the release rate of nuclide i, in Ci/year;
DF_i^{γ} or DF_i^{β}	=	the gamma and beta air dose factors for a uniform semi-infinite cloud of radionuclide i, in mrad-m^3/pCi-year.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_i^{\gamma} \, or \, Dose_i^{\beta}}{Q_i} = 3.17E{+}04\left(\frac{\chi}{Q}\right)\left(DF_i^{\gamma} \, or \, DF_i^{\beta}\right)$$

The values used in the equation above are:

χ/Q = 9.36E-07 seconds/m^3 (This value taken from Table I.4-2 of the FSAR, release mode 1B, intermittent, annual average, site boundary.);

$DE_i^{\gamma} \, or \, DF_i^{B}$ = Values used are taken from Table B-1 of RG 1.109.

C1.3.2 Annual Skin Dose From All Noble Gas Releases

The skin dose from the submersion of individuals in air containing noble gases was calculated using the equation:

$$\text{Dose} = 3.17E{+}04\left(\frac{\chi}{Q}\right)\left(1.11 S_F \sum_i Q_i DF_i^{\gamma} + \sum_i Q_i DFS_i\right)$$

where:

Dose = the annual skin dose due to immersion in a semi-infinite cloud, in mrem/year;

3.17E+04 = the number of pCi/Ci divided by the number of sec/year;

1.11 = the average ratio of tissue to air energy absorption coefficients;

S_F = the attenuation factor that accounts for the dose reduction due to shielding provided by residential structures, dimensionless;

χ/Q = the annual average atmosphere dispersion factor, in sec/m^3 (The location at which the dose was calculated was the site boundary in the south sector - a distance of 1270 meters.);

Q_i = the release rate of nuclide i, in Ci/year;

DF_i^γ = the annual gamma air dose factor for a uniform semi-infinite cloud of nuclide i, in mrad-m^3/pCi-year;

DFS_i = the beta skin dose factor for a semi-infinite cloud of nuclide i, which includes the attenuation by 7 mg/cm^2 of skin, in mrem-m^3/pCi-year.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_i}{Q_i} = 3.17E+04\left(\frac{\chi}{Q}\right)\left(1.11\,S_F DF_i^\gamma + DFS_i\right)$$

The values used in the equation above are:

S_F = 1 (No structural shielding is assumed.);

χ/Q = 9.36E-07 seconds/m^3 (This value taken from Table I.4-2 of the FSAR, release mode 1B, annual average, site boundary.);

DF_i^γ = Values used are taken from Table B-1 of RG 1.109;

DFS_i = Values used are taken from Table B-1 of RG 1.109.

C1.3.3 Annual Total Body Dose From All Noble Gas Releases

The total body dose from the submersion of individuals in air containing noble gases was calculated using the equation:

$$Dose = 3.17E+04\,S_F\left(\frac{\chi}{Q}\right)\sum_i Q_i DFB_i$$

where:

Dose = the annual total body dose due to immersion in a semi-infinite cloud, in mrem/year;

3.17E+04 = the number of pCi/Ci divided by the number of sec/year;

S_F = the attenuation factor that accounts for the dose reduction due to shielding provided by residential structures, dimensionless;

χ/Q = the annual average atmosphere dispersion factor, in sec/m^3 (The location at which the dose was calculated was the site boundary in the south sector - a distance of 1270 meters.);

Q_i = the release rate of nuclide i, in Ci/year;

DFB_i = the total body dose factor for a uniform semi-infinite cloud of nuclide i, which includes the attenuation of 5 g/cm^2 of tissue, in mrem-m^3/pCi-year.

To calculate the dose per curie released, the equation above was rearranged and the calculation performed for each nuclide. The rearranged equation is shown below:

$$\frac{Dose_i}{Q_i} = 3.17E+04\, S_F \left(\frac{\chi}{Q}\right) DFB_i$$

The values used in the equation above are:

S_F = 1 (No structural shielding is assumed.);

χ/Q = 9.36E-07 seconds/m^3 (This value taken from Table I.4-2 of the FSAR, release mode 1B, annual average, site boundary.);

DFB_i = Values used are taken from Table B-1 of RG 1.109.

APPENDIX D

DERIVATION OF DILUTION FACTORS

USING

REGULATORY GUIDE 1.113

D1.0 Liquid Effluent Dilution Factor Calculations

D1.1 Methodology

The dilution factors used for calculating the doses from liquid effluent released to Lake Michigan were calculated using the methodology of Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I." The parameters used in the calculation and the results of the calculation are given in Table D-1. The results are presented graphically in Figure D-1.

The centerline and shoreline values were calculated using Reg Guide 1.113 formulae 17 and 18 which apply to discharges to the Great Lakes. (The formulae are not presented here. See Section 5 of the PBNP FSAR for the formulae and origin of values used.) These results are applied as calculated for fish caught near PBNP. But for other pathways, an extra factor of two (2) is applied to account for current reversals which occur in Lake Michigan as described in the Appendix I, Section 5, of the PBNP FSAR.

TABLE D-1
SURFACE DILUTION FACTORS
LIQUID EFFLUENTS IN A LARGE LAKE

Downstream Distance (meters)	Plume Centerline	Shoreline
10	8.81	
20	8.81	
30	8.81	
40	8.81	
50	8.81	
60	8.81	
70	8.81	
80	8.81	
90	8.81	
100	8.81	
200	8.81	
300	8.81	
400	8.81	
500	8.81	
600	8.81	
700	8.81	
800	8.81	
900	8.81	
1000	8.81	122000
2000	8.86	1758
3000	9.01	401
4000	9.25	186
5000	9.53	116
6000	9.85	83.8
7000	10.2	65.9
8000	10.5	54.9
9000	10.8	47.4
10000	11.1	42.1
20000	14.0	24
30000	16.1	20.1
40000	17.7	18.7
50000	18.8	18.3
60000	19.6	18.2
70000	20.3	18.3
80000	20.9	18.6
90000	21.4	18.9
100000	21.9	19.2
200000	25.9	23.2
300000	29.2	26.9
400000	32.3	30.3
500000	35.2	33.3
600000	37.8	36.0
700000	40.2	38.6
800000	42.6	41.0
900000	44.8	43.3
1000000	46.9	45.5

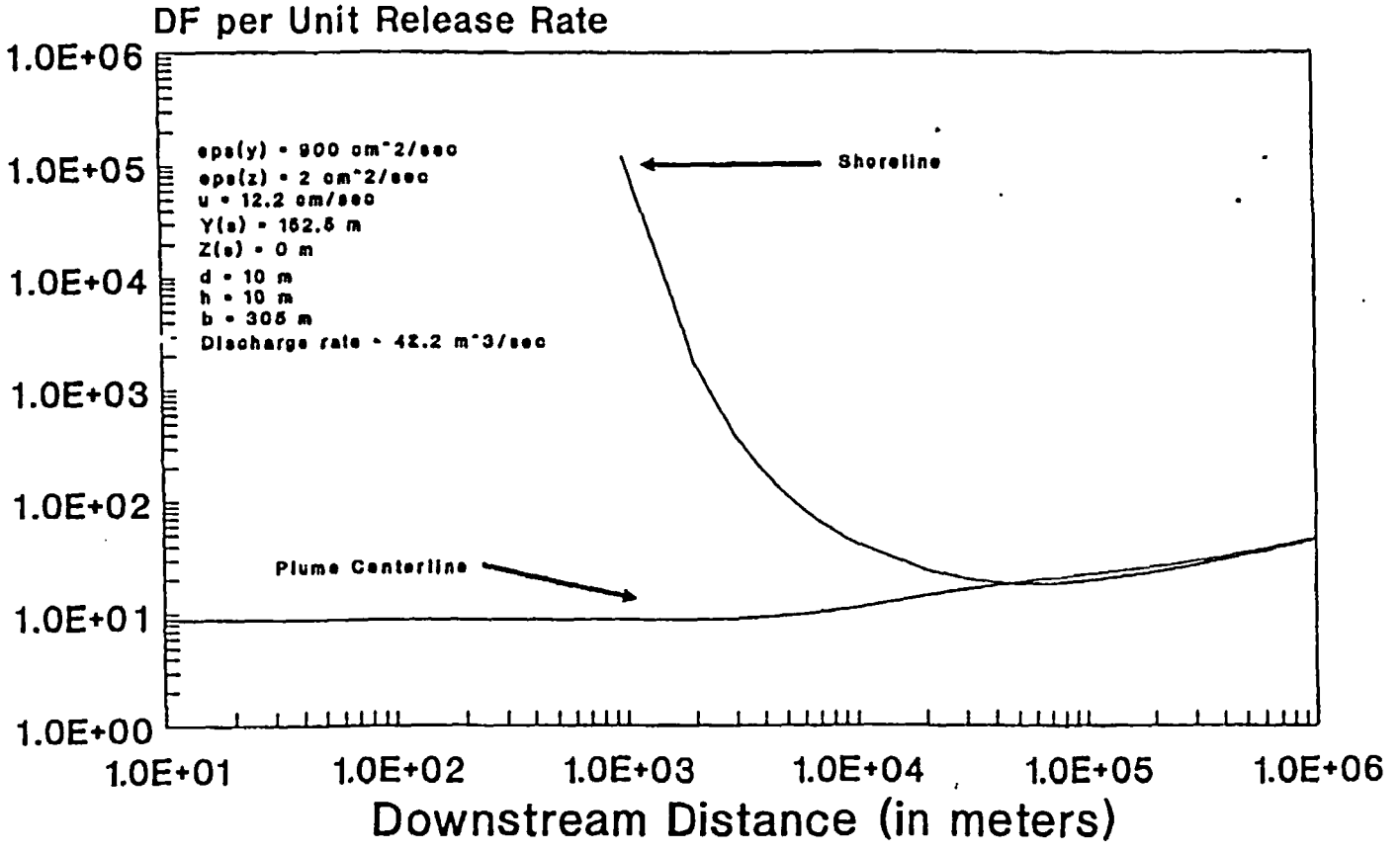
NOTE: **These values were calculated using the equation described in Section 5.2 of the PBNP FSAR and the following values:**

ϵ_y	=	*900 cm²/sec*	z_s	=	*0 meters*
ϵ_z	=	*2 cm²/sec*	d	=	*10 meters*
u	=	*12.2 cm/sec*	h	=	*10 meters*
y_s	=	*152.5 meters*	b	=	*305 meters*

and a discharge rate of 42.2 m³/sec.

Dilution Factor at Surface

Liquid Effluents in a Large Lake



Area source, width 305 m and height 10 m

FIGURE D-1
DILUTION FACTOR AT SURFACE

D1.2 Dilution Factor Twelve Miles Downstream: Two Rivers Water Intake

The dilution factor used at the Two Rivers water intake twelve miles downstream from PBNP included the factor of two described in Section D1.1. However, instead of using the straight centerline dilution factor shown in Table 1, the weighted average dilution factor calculated over the width of the plume was used.

This approach was used for the following reasons. First, the path that the current takes to reach the Two Rivers water intake is not straight. In order to reach Two Rivers, the water must flow southeast around Point Beach State Park, which juts into Lake Michigan, and then curves back 90 degrees towards Two Rivers. As a result of this deviation from straight line flow, any part of the plume or possibly none of the plume would impinge upon the intake structure.

Second, there is a difference in the distance offshore of the PBNP discharge and the Two Rivers water intake. The Two Rivers water intake is located 5080 feet offshore. By contrast, PBNP discharges close to the shoreline through two flumes, one directed north and one directed south, and is modeled as a source that extends 1000 feet out into the lake from the shoreline.

Based on these two considerations, it was concluded that the weighted average dilution across the width of the plume as it diverges while flowing south would constitute a better estimate of the dilution factor instead of the calculated for the centerline of an area source as is assumed for the FSAR calculation. The calculation and the values used are shown below.

The average dilution factor at 12 miles downstream was calculated in the following manner:

1. The standard deviation of the radionuclide concentration in the y direction at 12 miles downstream on the surface of the lake was calculated. This calculation used the following formula:

$$\sigma_y = \sqrt{\frac{2 \times \varepsilon_y \times x}{u}}$$

where

ϵ_y = lateral turbulent diffusion coefficient in cm^2/sec

x = the downstream distance in cm

u = current in cm/sec

Substituting the values for ϵ_y, x, and u of 900 cm^2/sec, 19308 m, and 12.2 cm/sec, respectively, into the equation yields

$$\sigma_y = \frac{\sqrt{\dfrac{2 \times 900 \frac{cm^2}{sec} \times 19308\,m \times 100 \frac{cm}{m}}{12.2 \frac{cm}{sec}}}}{100 \frac{cm}{m}} = 168.8 \text{ meters}$$

2. At distances of 0.1σ, 0.2σ, etc., off the plume centerline, the dilution factor was calculated using the equation shown in Section 5.2 of the PBNP FSAR. The distances off the plume centerline, the calculated dilution factor, and the fraction of the area under the normal distribution curve is listed below.

Distance Off Plume Centerline

Fraction of Standard Deviation	Equivalent Distance (m)	Fraction of Total Area Under the Curve for Interval	Dilution Factor
0.1σ	16.9	0.080	13.8
0.2σ	33.8	0.080	14.0
0.3σ	50.6	0.078	14.3
0.4σ	67.5	0.075	14.7
0.5σ	84.4	0.072	15.2
0.6σ	101.3	0.068	15.8
0.7σ	118.1	0.065	16.6
0.8σ	135.0	0.060	17.6
0.9σ	151.9	0.056	18.8
1.0σ	168.8	0.051	20.2
1.1σ	185.6	0.046	21.9
1.2σ	202.5	0.042	23.9
1.3σ	219.4	0.037	26.3
1.4σ	236.3	0.032	29.2
1.5σ	253.2	0.028	32.6
1.75σ	295.4	0.053	44.7
2.0σ	337.6	0.035	64.7
2.25σ	379.8	0.021	98.4
2.5σ	421.9	0.012	158.4
3.0σ	506.3	0.010	482
Totals		1.00	

OFFSITE DOSE CALCULATION MANUAL

* It is assumed that the standard deviation of the radionuclide concentrations across the plume can be represented by a normal distribution curve. The fraction of the total area under the curve is that fraction of the area under the curve that lies between, for example, the interval 0.1σ and 0.2σ which also includes the area of the curve in the interval -0.1σ and -0.2σ.

  The average dilution factor over the width of the plume was calculated by multiplying the dilution factor at each of the locations off of the plume centerline by the fraction of the total area of the curve occupied by that interval and then summing over all the intervals. An average dilution actor of 29 was calculated.

RECM

RADIOLOGICAL EFFLUENT CONTROL MANUAL

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1.0 RADIOLOGICAL EFFLUENT CONTROL PROGRAM

1.1 Basis

The Radiological Effluent Control Program (RECP) shall conform to 10 CFR 50.36a for the control of radioactive effluents and maintaining doses to members of the public from radioactive effluents as low as reasonably achievable (ALARA). The RECP also is established to control the amount and concentrations of radioactivity in PBNP effluent pursuant to the following documents:

1.1.1 10 CFR 50.34a-Design objectives for equipment to control releases of radioactive material in effluents-nuclear power reactors,

1.1.2 10 CFR 50, Appendix A, Criterion 60-Control of releases of radioactive material to the environment,

1.1.3 10 CFR 50, Appendix A, Criterion 63-Monitoring fuel and waste storage,

1.1.4 10 CFR 50, Appendix A, Criterion 64-Monitoring radioactivity releases,

1.1.5 10 CFR 20.1302-Compliance with dose limits for individual members of the public,

1.1.6 10 CFR 20.1501-General,

1.1.7 PBNP General Design Criterion 17-Monitoring Radioactivity Releases, and

1.1.8 PBNP General Design Criterion 70-Control of releases of radioactivity to the environment.

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1.2 Basis Statement

Liquid effluent from the radioactive waste disposal system is diluted by the circulating water system prior to release to Lake Michigan. With two pumps operating per unit, the flow of the circulating water system is approximately 340,000 gpm per unit. Operation of a single circulating water pump per unit reduces the nominal flow rate by about 40%. Liquid waste from the waste disposal system may be discharged to the circulating water system of either unit via the service water return header. Because of the low radioactivity levels in the circulating water discharge, the concentrations of liquid radioactive effluents at this point are not measured directly. Instead, the concentrations in the circulating water discharge are calculated from the measured concentration of the liquid effluent, the discharge flow rate of the effluent and the nominal flow in the circulating water system.

The release of radioactive materials in liquid effluents to unrestricted areas is monitored and controlled to conform to the dose objectives in Section II.A of Appendix I to 10 CFR 50 and will be as low as reasonably achievable (ALARA) in accordance with the requirements of 10 CFR Parts 50.34a and 50.36a. The monitoring and control also is undertaken to keep the concentrations of radionuclides in PBNP liquid effluent released to unrestricted areas conforming to ten times the maximum effluent concentration (MEC) values specified in Table 2, Column 2 of Appendix B to 10 CFR 20.1001-20.2402. Furthermore, the appropriate portions of the liquid radwaste treatment systems will be used as required to keep the releases ALARA.

These actions provide reasonable assurance that the resulting average annual dose or dose commitment from liquid effluent from each unit of the Point Beach Nuclear Plant for any individual in an unrestricted area from all pathways of exposure will not exceed the 10 CFR 50, Appendix I dose objectives. Thus, discharge of liquid wastes not exceeding these release limits will not result in significant exposure to members of the public because of consumption of drinking water from the lake, even if the effect of potable water treatment systems on reducing radioactive concentrations of the water supply is conservatively neglected.

Prior to release to the atmosphere, gaseous wastes are mixed in the auxiliary building vent with the flow from at least one of two auxiliary building exhaust fans. Further dilution then occurs in the atmosphere. Release of radionuclides to the atmosphere is monitored and controlled so that effluents to unrestricted areas conform to the dose objectives of Sections II.B and C of Appendix I to 10 CFR 50. Monitoring and control also is undertaken to ensure that at the point of maximum ground concentration at the site boundary, the radionuclide concentrations in the atmosphere will conform to the limits specified in Table 2, Column 1 of Appendix B to 10 CFR 20. Furthermore, the appropriate portions of the gaseous radwaste treatment system are used as required to keep the radioactive releases to the atmosphere ALARA.

In order to achieve the dose objectives of Appendix I to 10 CFR 50 and the aforementioned concentration limits, the setpoints for releases to the atmosphere and to Lake Michigan utilize the methodology found in the Offsite Dose Calculation Manual. Setpoints for releases to the atmosphere are based on the dilution provided by building vents as well as the highest annual average χ/Q at the site boundary. Setpoints for releases to Lake Michigan are based only on dilution by circulation water. Together, control and monitoring provide reasonable assurance that the annual dose from each unit's effluents, to an individual in an unrestricted area will not exceed the dose objectives of Appendix I to 10 CFR 50.

Implementation of the RECP will keep average annual releases of radioactive material in PBNP effluents and their resultant committed effective dose equivalents at small percentages of the dose limits specified in 10 CFR 20.1301. At the same time, the methodology of implementing the RECP permits the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided with a dependable source of power even under unusual operating conditions which may temporarily result in releases higher than such numerical guides for design objectives set forth in Appendix I but still within levels that assure that the average population exposure is equivalent to small fractions of doses from natural background radiation.

Compliance with the provisions of Appendix I to 10 CFR Part 50 constitutes adequate demonstration of conformance to the standards set forth in 40 CFR Part 190 regarding the dose commitment to individuals from the uranium fuel cycle.

1.3 Responsibilities

All required actions of the Radiological Effluent Control Program shall be conducted using approved procedures. The responsibility for the implementation of the approved procedures resides with the Manager-PBNP.

1.4 Manual Revisions

Revisions to this manual shall be performed in accordance with the ODCM Section 1.3.

1.5 RECP Parameters Reportable in the Annual Monitoring Report

Information relative to the monthly quantities of liquid, gaseous, and solid radioactive effluents released from PBNP and effluent volumes used in maintaining the releases within 10 CFR 20 limits shall be reported in the Annual Monitoring Report as follows:

1.5.1 Liquid Releases

a. Total radioactivity in curies released and average diluted discharge concentrations of the following release categories: gamma isotopic, gross alpha, tritium, and strontium (beta emitters other than tritium).

b. Total volume (in gallons) of liquid waste released into circulating water discharge.

c. Total volume (in gallons) of dilution water used.

d. The maximum concentration of tritium and gross gamma radioactivity released (averaged over the period of a single release).

e. Estimated monthly total radioactivity in curies of individual radionuclides released based on representative isotopic analyses.

f. Semiannual and annual totals of monthly quantities of individual radionuclides, as determined by isotopic analyses.

1.5.2 Releases to the Atmosphere

a. Total gross radioactivity (in Curies), by month, released of:

1. Noble Gases.

2. Halogens.

3. Particulates, subdivided into beta emitters (strontium, etc.), gross alpha, and gamma emitters.

4. Tritium.

b. Maximum release rate (for any one-hour period).

c. Estimated monthly total radioactivity (in Curies) released, by nuclide, for I-131, I-133, H-3, and radioactive particulates with half-lives greater than eight days, based on representative analyses performed by beta and by gamma isotopic analyses.

d. Semiannual and annual totals of monthly isotopic radionuclide quantities.

1.5.3 Solid Waste

a. The total amount of solid waste shipped, buried, or stored (in cubic feet).

b. Estimated total radioactivity and isotopic content (in Curies) determined by scaling factors, gamma isotopic and/or other suitable analyses.

c. The dates of shipment and burial site if shipped for burial.

d. The type of waste shall be indicated, i.e., dry activated waste, resins, evaporator concentrates, filters, scrap metal, asbestos, etc.

1.5.4 Doses

The air doses and the doses to the hypothetical maximum exposed individual calculated following the ODCM methodology shall be reported.

1.5.5 Meteorological Data

Meteorological data shall be kept in file on site for review by the NRC upon request. The data available will include wind speed, wind direction and atmospheric stability. The data will be stored in an electronic form for each of the parameters.

1.6 Other RECP Reportable Events

1.6.1 Radioactive Effluent Non-Treatment

If the effluent treatment system for radioactive liquids or for releases to the atmosphere is inoperable and effluents are being discharged for 31 consecutive days without the treatment required to meet the release limits specified in Section 5.0, a special report shall be prepared and submitted to the Commission within thirty days which includes the following information:

a. Identification of the inoperable equipment or subsystem and the reason for inoperability.

b. Actions taken to restore the inoperable equipment to operable status.

c. Summary description of actions taken to prevent a recurrence.

1.6.2 Radioactive Effluent Release Limit Exceedence

If the quantity of radioactive material actually released in liquid or gaseous effluents during any calendar quarter exceeds twice the quarterly limit as specified in Section 5.0, a special report shall be prepared and submitted to the Commission within thirty days of determination of the release quantity.

The report must describe the extent of exposure of individuals to radiation and radioactive material, including as appropriate:

a. the corrective action(s) to be taken to reduce subsequent releases to prevent recurrence of exceeding the limits, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license conditions,

b. estimates of exposures to a member of the public, including the dose from any external storage units, such as the ISFSI and the SGSF, for compliance with 40 CFR 190 limits,

c. the levels of radiation and concentrations of radioactive materials involved, and

d. the cause of the elevated exposures, dose rates, or concentrations.

If the dose to any member of the public exceeds 75 mrem to the thyroid or 25 mrem to the whole body or any organ other than the thyroid, pursuant to 40 CFR 190, the report shall also contain a request for a variance from this standard pursuant to 40 CFR 190.11.

1.6.3 Major Change to Radioactive Liquid, Gaseous and Solid Waste Treatment Systems

Licensee initiated major changes to the radioactive waste treatment systems (liquid, gaseous, and solid) shall be reported to the U.S. Nuclear Regulatory Commission with the annual update to the FSAR for the period in which the major change was complete. The discussion of each change shall include:

a. A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR Part 50.59;

b. Information necessary to support the reason for the change;

c. A description of the equipment, components and processes involved and the interfaces with other plant systems;

d. An evaluation of the change, which shows how the predicted releases of radioactive materials in liquid effluents and gaseous effluents and/or quantity of solid waste will differ from those previously predicted in the license application and amendments thereto;

e. An evaluation of the change, which shows the expected maximum exposures to an individual in the unrestricted area and to the general population that differ from those previously estimated in the license application and amendments thereto;

f. An estimate of the exposure to plant operating personnel because of the change.

1.7 Audits

The activities of the Radiological Effluent Controls Program as described in this manual and its implementing procedures shall be audited in accordance with ODCM Section 1.4.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

2.0 RADIOACTIVE EFFLUENT CONTROL

2.1 Liquid Radioactive Effluent Treatment System

The liquid radioactive effluent treatment system consists of those components or devices used to reduce radioactive material in liquid effluent. The system consists of the following:

2.1.1 blowdown evaporator or waste evaporator,

2.1.2 polishing demineralizers,

2.1.3 boric acid evaporator feed demineralizers,

2.1.4 boric acid evaporators,

2.1.5 boric acid evaporator condensate demineralizers.

2.2 Gaseous Radioactive Effluent Treatment System

The gaseous radioactive effluent treatment system consists of those components or devices utilized to reduce radioactive material in effluent released to the atmosphere. The system consists of the following:

2.2.1 gas decay tanks,

2.2.2 drumming area ventilation exhaust duct filter assembly,

2.2.3 Unit 1 and 2 containment purge exhaust filter assemblies,

2.2.4 air ejector decay duct filter assembly,

2.2.5 auxiliary building ventilation filter assembly (nominal 11,214 cfm exhaust pathway),

2.2.6 chemistry laboratory exhaust duct filter assembly,

2.2.7 service building ventilation exhaust duct filter assembly,

2.2.8 auxiliary building ventilation filter assemblies (nominal 34,150 cfm exhaust pathway).

2.3 Effluent Control and Accountability

2.3.1 Radiation Monitoring System

a. Description

The computerized Radiation Monitoring System (RMS) at Point Beach Nuclear Plant consists of area and process monitors. The effluent monitors are those process monitors that are designed to detect and measure radioactivity in liquid and gaseous releases from PBNP. A description of the liquid and gaseous effluent monitors and associated isolation and control functions are presented in the ODCM.

b. Calibration

Calibration of the RMS detectors is accomplished according to the procedures of the PBNP Health Physics Calibration Manual.

c. Setpoints

The methodology for determining effluent RMS detector setpoints is described in the ODCM.

d. Alarms

Response to alarms received from RMS effluent detectors is described in the PBNP RMS Alarm Setpoint and Response Book.

e. Effluent Detector Operability and Surveillance

Detector operability and surveillance requirements are addressed in Sections 3.0 and 4.0 of this manual.

2.3.2 Effluent Treatment Schematic

The liquid and gaseous waste processing flow paths, equipment, and radiation monitors are depicted in the ODCM.

2.3.3 Release Accountability

Control and accountability of radioactivity in PBNP effluents is accomplished by the RMS in conjunction with the characterization of radionuclide distributions by laboratory analyses of grab samples from the various waste streams. Sampling frequencies and analysis requirements are set forth in Section 6.0 of this manual. Additional aspects of grab sampling and release accountability are described in the PBNP Release Accountability Manual.

3.0 RADIOACTIVE EFFLUENT MONITORING INSTRUMENTATION OPERABILITY REQUIREMENTS

3.1 Objective

The operability of detectors is specified in order to ensure that liquid and gaseous radioactive effluents are adequately monitored and to ensure that alarm or trip setpoints are established such that effluent releases do not exceed the values cited in Section 5.0.

3.2 Operability Specifications

3.2.1 The radioactive effluent monitoring instrumentation channels listed in Tables 3-1 and 3-2 shall be operable. The alarm or trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

3.2.2 If fewer than the minimum number of radioactive effluent monitoring channels are operable, the action statement listed in either Table 3-1 or 3-2 opposite the channel shall be taken. Best effort shall be made to return an inoperable channel to operable status within 30 days. If the channel is not returned to an operable status within 30 days, the circumstances of the instrument failure and schedule for repair shall be reported to the NRC Resident Inspector.

3.2.3 If a radioactive effluent monitoring instrumentation channel alarm or trip setpoint is found less conservative than required by the ODCM, the channel shall be declared inoperable or the setpoint shall be changed to the ODCM value or a more conservative value.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 3-1
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

Instrument			Minimum Channels Operable	Action
1.	Liquid Radwaste System			
	a.	RE-223, Waste Distillate Tank Discharge	1	Note 9
	b.	RE-218, Waste Condensate Tank Discharge	1	Note 9
	c.	Waste Condensate Tank Discharge Flow Meter	1	Note 4
	d.	Waste Distillate Tank Flow Rate Recorder	1	Note 4
2.	Steam Generator Blowdown System			
	a.	For Each Unit; RE-219, Steam Generator Blowdown Liquid Discharge, or RE-222, Blowdown Tank Monitor, or RE-229, Service Water Discharge	1	Note 2
	b.	Steam Generator Blowdown Flow Indicators (1 per steam generator)	1	Note 8
3.	Service Water System			
	a.	RE-229, Service Water Discharge (1 per unit)	1	Note 3
	b.	For Each Unit; RE-216, Containment Cooling Fan Service Water Return, or RE-229, Service Water Discharge	1	Note 3
	c.	RE-220, Spent Fuel Pool Heat Exchanger Service Water Outlet or RE-229, Service Water Discharge (for applicable unit)	1	Note 3

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4.	Waste Water Effluent			
	a.	RE-230, Waste Water Effluent	1	Note 3
	b.	Waste Water Effluent Composite Sampler	1	Note 7
	c.	Waste Water Effluent Flow Determination	NA	*

* Waste water effluent flow may be determined from the waste water effluent flow meter.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 3-2
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Instrument			Minimum Channels Operable	Action
1.	Gas Decay Tank System			
	a.	RE-214, Noble Gas (Auxiliary Building Vent Stack), or RE-315 Noble Gas (Auxiliary Building Vent SPING)	1	Note 1
	b.	Gas Decay Tank Flow Measuring Meter	1	Note 4
2.	Auxiliary Building Ventilation System			
	a.	RE-214, Noble Gas (Auxiliary Building Vent Stack) or Re-315, Noble Gas (Auxiliary Building Vent SPING)	1	Note 6
	b.	Isokinetic Iodine and Particulate - Continuous Air Sampling System or SPING 23	1	Note 5
3.	Condenser Air Ejector System			
	a.	RE-225, Noble Gas (Combined Air Ejector Discharge Monitor); or RE-215, Noble gas (Air Ejector Monitors - 1 per unit); or RE-214, Noble Gas (Auxiliary Building Vent Stack); or RE-315, Noble Gas (Auxiliary Building Vent SPING)	1	Note 6
	b.	Flow Rate Monitor - Air Ejectors	1	Note 8

TABLE 3-2

4.	Containment Purge and Vent System			
	a.	RE-212, Noble Gas Monitors (1 per unit); or RE-305, Noble Gas (Purge Exhaust SPING - 1 per unit)	1	Note 6
	b.	30 cfm Forced Vent Path Flow Indicators	1	Note 6
	c.	Iodine and Particulate - Continuous Air Samplers or SPING 21/22	1	Note 5
	d.	Sampler Flow Rate Measuring Device	1	Note 6
5.	Fuel Storage and Drumming Area Ventilation System			
	a.	RE-221, Noble Gas (Drumming Area Stack), or RE-325, Noble Gas (Drumming Area SPING)	1	Note 6
	b.	Isokinetic Iodine and Particulate - Continuous Air Sampling System or SPING 24	1	Note 5
6.	Gas Stripper Building Ventilation			
	a.	RE-224, Noble Gas (Gas Stripper Building), or RE-305, (Unit 2 Purge Exhaust SPING)	1	Note 6
	b.	Iodine and Particulate - Continuous Air Sampler or SPING 22	1	Note 5
	c.	Sampler Flow Rate Measuring Device	1	Note 8

NOTATIONS FOR TABLES 3-1 AND 3-2

Note 1: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided that prior to initiating a release, two separate samples are analyzed by two technically qualified people in accordance with the applicable part of Table 6-2 and the release rate is reviewed by two technically qualified people.

Note 2: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided grab samples are analyzed for gamma radioactivity in accordance with Table 6-1 at least once every 24 hours when the secondary coolant specific activity is less than 0.01 μCi/cc dose equivalent I-131 or once every 12 hours when the activity is greater than 0.01 μCi/cc dose equivalent I-131.

Note 3: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided that at least once every 12 hours grab samples are collected and analyzed in accordance with Table 6-1.

Note 4: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided the flow rate is estimated at least once every four hours during actual gaseous or liquid batch releases.

Note 5: If the number of channels operable is fewer than the minimum required, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment, (e.g., any low volume sampler which meets the requirements of Table 6-2).

Note 6: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided grab samples are collected at least once per 12 hours and are analyzed in accordance with Table 6-2.

Note 7: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided grab samples are collected twice per week and analyzed in accordance with Table 6-1.

Note 8: If the number of channels operable is fewer than the minimum required, effluent releases via this pathway may continue provided the flow is estimated or determined with auxiliary indication at least once every 24 hours.

Note 9: If the number of channels operable is fewer than the minimum required, efflent releases via this pathway shall be discontinued immediately (reference TRM 3.3.1).

RADIOLOGICAL EFFLUENT CONTROL MANUAL

4.0 RADIOACTIVE EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

4.1 Objective

To verify that radioactive liquid and gaseous effluent monitoring instrumentation is demonstrated to be operable by periodic inspection, testing, and calibration.

4.2 Radioactive Monitoring Instrumentation Surveillance Requirements

Each radioactive effluent monitoring instrumentation channel shall be demonstrated operable by performance of the channel check, calibration, functional test, and source check at the frequencies shown in Tables 4-1 and 4-2.

4.3 Definitions

4.3.1 Source Check

The assessment of channel response by exposing the channel detector to a source of increased radiation.

4.3.2 Channel Check

A qualitative determination of acceptable operability by observing channel behavior during operation. This shall include comparison of the channel with other independent channels measuring the same variable.

4.3.3 Functional Test

The injection of a simulated signal into the channel to verify that it is operable, including alarm and/or trip initiating action.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 4-1
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument Description	Channel Check	Calibrate	Functional Test	Source Check
1. Liquid Radwaste System				
a. RE-223, Waste Distillate Tank Discharge	D	R	Q	P
b. RE-218, Waste Condensate Tank Discharge	D	R	Q	P
c. Waste Condensate Tank Discharge Flow Meter	P/D	R	NA	NA
d. Waste Distillate Tank Flow Rate Recorder	P/D	R	NA	NA
2. Steam Generator Blowdown System				
a. RE-219, Steam Generator Blowdown Liquid Discharge (1 per unit)	D	R	Q	M
b. RE-222, Blowdown Tank Monitor (1 per unit)	D	R	Q	M
c. Steam Generator Blowdown Flow Indicator (1 per steam generator)	D	R	NA	NA

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 4-1 (continued)
RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument Description	Channel Check	Calibrate	Functional Test	Source Check
3. Service Water System				
a. RE-229, Service Water Discharge (1 per unit)	D	R	Q	M
b. RE-216, Containment Cooling Fan Service Water Return (1 per unit)	D	R	Q	M
c. RE-220, Spent Fuel Pool Heat Exchanger Service Water Outlet	D	R	Q	M
4. Waste Water Effluent				
a. RE-230, Waste Water Effluent	D	R	Q	M
b. Waste Water Effluent Composite Sampler	W	NA	NA	NA
c. Waste Water Effluent Flow Meter	W	R	NA	NA

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 4-2
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Channel Description	Channel Check	Calibrate	Functional Test	Source Check
1. Gas Decay Tank System				
a. RE-214, Noble Gas (Auxiliary Building Vent Stack	D	R	Q	M
b. Gas Decay Tank Flow Measuring Device	P	R	NA	NA
2. Auxiliary Building Ventilation System				
a. RE-214, Noble Gas (Auxiliary Building Vent Stack)	D	R	Q	M
b. RE-315, Noble Gas (Auxiliary Building SPING	D	R	Q	M
c. Isokinetic Iodine and Particulate Continuous Air Sampling System	W	R	NA	NA

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 4-2 (continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Channel Description	Channel Check	Calibrate	Functional Test	Source Check
3. Condenser Air Ejector System				
a. RE-225, Noble Gas (Combined Air Ejector Discharge)	D	R	Q	M
b. RE-215, Noble Gas (Air Ejectors - 1 per unit)	D	R	Q	M
c. Flow Rate Monitor - Air Ejectors (1 per unit)	D	R	NA	NA
4. Containment Purge and Vent System				
a. RE-212, Noble Gas (1 per unit)	D	R	Q	M*
b. 30 cfm Vent Path Flow Indicator	P/D	R	NA	NA
c. RE-305, Noble Gas (Purge Exhaust SPING - 1 per unit)	D	R	Q	M*
d. Iodine and Particulate Continuous Air Sampler	P/W	NA	NA	NA
e. Sampler Flow Rate Measuring Device	P/D	R	NA	NA

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 4-2 (continued)
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Channel Description	Channel Check	Calibrate	Functional Test	Source Check
5. Fuel Storage and Drumming Area Ventilation Stack				
a. RE-221, Noble Gas (Drumming Area Vent Stack)	D	R	Q	M
b. RE-325, Noble Gas (Drumming Area SPING)	D	R	Q	M
c. Isokinetic Iodine and Particulate Continuous Air Sampling System	W	NA	NA	NA
6. Gas Stripper Building Ventilation System				
a. RE-224 Noble Gas	D	R	Q	M
b. Iodine and Particulate Continuous Air Sampler	W	NA	NA	NA
c. Sampler Flow Rate Measuring Device	W	R	NA	NA

RADIOLOGICAL EFFLUENT CONTROL MANUAL

NOTATIONS FOR TABLES 4-1 AND 4-2

D	=	Daily
W	=	Weekly
M	=	Monthly
Q	=	Quarterly
R	=	Each Refueling Interval
P/D	=	Prior to or immediately upon initiation of a release or daily if a release continues for more than one day
P/W	=	Prior to or immediately upon initiation of a release or weekly if a release continues for more than one week
P	=	Prior to or immediately upon initiation of a release
*	=	Source check required prior to containment purge
**	=	The channel calibration shall include the use of standard gas samples appropriate to the recommendations of the manufacturer of the gas analyzer equipment in use and include calibration points in the range of interest.
NA	=	not applicable

5.0 RADIOACTIVE EFFLUENT RELEASE LIMITS

5.1 Objective

To ensure controlled releases of radioactive materials in liquid and gaseous effluents to unrestricted areas are within applicable 10 CFR 20 concentration limits and to ensure the quantities of radioactive material released during any calendar year are such that resulting radiation exposures do not exceed the dose objectives of 10 CFR 50, Appendix I.

5.2 Radioactive Liquid Effluent Concentrations

5.2.1 Alarm setpoints for liquid effluent monitors shall be determined and adjusted utilizing the methodologies and parameters given in the ODCM.

5.2.2 The liquid effluent monitor setpoints shall be established to ensure that radioactive materials released as effluents shall not result in concentrations to unrestricted areas in excess of ten times the concentration values specified in Appendix B, Table 2, Column 2, of 10 CFR 20.1001-20.2402.

5.2.3 During release of radioactive liquid effluents, at least one condenser circulating water pump shall be in operation and the service water return header shall be lined up only to the unit whose circulating water pump is operating.

5.3 Radioactive Liquid Effluent Release Limits

5.3.1 The annual calculated total quantity of radioactive material above background released from PBNP in liquid effluents shall not result in an unrestricted area estimated annual dose or dose commitment from all exposure pathways to any individual in excess of 6 millirem to the total body or 20 millirem to any organ.

5.3.2 For the purpose of initiating the use of the liquid effluent treatment system whenever the projected dose for a period of 31 days will exceed 2% of the dose guidelines of Appendix I to 10 CFR 50, the 2% of the Appendix I values, as given in Section 5.3.1, are 0.12 mrem for the whole body and 0.4 mrem for any organ.

5.3.3 Quarterly limits are defined as one-half of the annual limits.

5.3.4 Compliance with these release limits will be demonstrated by periodic dose calculations utilizing the methodology of the ODCM.

5.4 Radioactive Gaseous Effluent Concentrations

5.4.1 Alarm setpoints for the gaseous effluent monitors shall be determined and adjusted utilizing the methodologies and parameters given in the ODCM.

5.4.2 The gaseous effluent monitor setpoints are established to ensure that radioactive materials released shall not result in concentrations to unrestricted areas in excess of the values specified in 10 CFR 20, Appendix B, Table 2.

5.4.3 During the release of radioactive gaseous effluents from the gas decay tanks through the auxiliary building vent, at least one auxiliary building exhaust fan shall be in operation.

5.5 Radioactive Gaseous Effluent Release Limits

5.5.1 The annual calculated total quantity of radioactive materials above background released from PBNP to the atmosphere shall not result in an unrestricted area estimated annual dose or dose commitment from all exposure pathways to any individual in excess of the following:

a. 10 millirem to the total body or 30 millirem to the skin from gaseous effluents near ground level;

b. 30 millirem to any organ from all I-131, I-133, H-3 and radioactive materials in particulate form whose half-life is > 8 days; and

c. Furthermore, the annual air dose from gaseous effluents at any location near ground level, which could be occupied by individuals in unrestricted areas, shall not exceed 20 millirads for gamma radiation or 40 millirads for beta radiation.

5.5.2 For the purpose of initiating the use of the atmospheric effluent treatment system whenever the projected dose for a period of 31 days will exceed 2% of the dose guidelines of Appendix I to 10 CFR 50, the 2% of the Appendix I values, as given in Section 5.5.1, are:

a. 0.2 mrem to the total body and 0.6 mrem to the skin, and

b. 0.6 mrem to any organ.

5.5.3 Quarterly limits are defined as one-half of the annual limits.

5.5.4 Compliance with these release limits will be demonstrated by periodic dose calculations utilizing the methodology of the ODCM.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

5.6 Atmospheric Release Rate Limitations

The rate of release of radioactive effluents to the atmosphere from the site, which if continued for one year, shall not result in dose rates at or beyond the site boundary that exceed the following values.

5.6.1 For noble gases:

a. 500 mrem/yr to the total body

b. 3000 mrem/yr to the skin

5.6.2 For I-131, I-133, H-3, and all particulate form radionuclides with a half-life > 8 days:

1500 mrem/yr to any organ

5.6.3 The instantaneous, limiting release rates for the above annual rates, are calculated in Section 3.10 of the ODCM for various release types. Below are default values for various releases. Check the ODCM for the methodology to calculate release rates for more specific radionuclide mixtures or contact the cognizant Radiological Engineer.

a. For noble gases, the whole body dose is limiting yielding a rate of 1.22E-01 Ci/sec.

b. For particulates, radioiodines and H-3, as described above, the release rates are

1.14E-06 Ci/sec for radioiodines

1.30E-06 Ci/sec for cesiums

2.16E-05 Ci/sec for cobalts

3.62E-01 Ci/sec for H-3

As a conservative measure, the limiting release rate should be applied to the whole radionuclide mixture based upon the presence or absence of the above major dose contributors.

5.7 Cumulative and Projected Doses

5.7.1 Determination of cumulative and projected dose contributions from radioactive effluents for the current calendar quarter and current calendar year, in accordance with the methodology and parameters of the ODCM, shall be made at least every 31 days.

5.7.2 Because of the length of time required to complete all facets of the required calculations and to obtain the radioanalytical results for effluent samples sent to a contracted analytical laboratory, the determination of the current quarter dose may not be finished until the following quarter.

5.7.3 If the calculations required by Sections 5.3.4 or 5.5.4 exceed the corresponding quarterly limit during any calendar quarter, a special report will be prepared and submitted.

5.7.4 If the calculations required by Sections 5.3.4 or 5.5.4 demonstrate that quarterly releases exceed the quarterly limit, corrective actions shall be taken to ensure that subsequent releases in that calendar year will comply with quarterly and annual limits.

5.8 Radioactive Effluent Treatment

5.8.1 The gaseous radioactive effluent treatment system shall be operated whenever the projected dose for a 31 day period, from I-131, I-133, H-3, and radioactive particulates with a half-life > 8 days, exceeds the values of Section 5.5.2 (2% of the Appendix I values). If the gaseous effluent treatment system becomes inoperable, the effluent reporting requirements of Section 1.6 shall apply.

a. A gas decay tank(s) shall be operated whenever required to maintain gaseous releases within the limits of Section 5.5.2.a.

b. The auxiliary building ventilation exhaust charcoal filter shall be operated when required to maintain gaseous releases within the limit of Section 5.5.2.b for radioiodines.

c. The air ejector charcoal filter shall be operated when required to maintain releases within the limit of Section 5.5.2.b for radioiodines.

5.8.2 The liquid radioactive effluent treatment system shall be operated whenever the projected dose for a 31 day period exceeds the values of Section 5.3.4 (2% of the Appendix I values). If the liquid effluent treatment system becomes inoperable, the effluent reporting requirements of Section 1.6 shall apply.

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5.9 Total Dose

5.9.1 Compliance with the provisions of Appendix I to 10 CFR 50 is adequate demonstration of conformance to the standards set forth in 40 CFR 190.

5.9.2 If the calculations required by 5.3.4 or 5.5.4 exceed twice the annual dose objectives of Sections 5.3 and 5.5 , dose calculations shall be performed as described in the ODCM and shall include direct radiation contributions from reactor units and from any outside storage tanks in addition to effluent pathways.

5.9.3 A report will be submitted to the Commission within 30 days upon completion of the dose calculations required by Section 5.9.2, if the calculated dose to any member of the general public exceeds the 40 CFR 190 annual dose limits.

5.10 Solid Radioactive Waste

The solid radwaste system shall be used in accordance with the Process Control Program to process radioactive wastes to meet all shipping and burial ground requirements. If the provisions of the Process Control Program are not satisfied, shipments of defectively processed or defectively packaged radioactive waste from the site will be suspended. The Process Control Program shall be used to verify solidification of radwaste.

6.0 RADIOACTIVE EFFLUENT SAMPLING AND ANALYSIS REQUIREMENTS

6.1 Purpose

Pursuant to the requirements of 10 CFR 20.1302, the purpose of this section is to specify the sampling frequency, the analysis frequency, and analysis requirements for radioactive liquid and gaseous effluents in order to verify that the concentrations and quantities of radioactive material released from the site in liquid and gaseous effluents do not exceed the objectives specified in Section 5.0.

6.2 Radioactive Liquid Waste Sampling and Analysis

The concentration of radioactivity in liquid waste shall be determined by sampling and analysis in accordance with Table 6-1.

6.3 Radioactive Gaseous Waste Sampling and Analysis

The concentration of radioactivity in gaseous wastes shall be determined by sampling and analyses in accordance with Table 6-2.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 6-1
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis[5]	Lower Level of Detection[1] (µCi/cc)
1. Batch Releases[2] a. Waste Condensate Tank b. Waste Distillate Tank c. Monitor Tanks d. Other tanks containing radioactivity to be discharged	Prior to Release	Prior to Release	Gamma Emitters I-131	5×10^{-7} 1×10^{-6}
		Monthly on composites obtained from batches released during the current month	Gross Alpha	1×10^{-7}
			Tritium	1×10^{-5}
		Quarterly on composites obtained from batches released during the current quarter	Sr-89/90	5×10^{-8}

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TABLE 6-1

2. Continuous Releases[3]

a. Steam Generator Blowdown	Grab Samples Twice Weekly	Twice Weekly	Gamma Emitters I-131	5×10^{-7} 1×10^{-6}
b. Service Water		Monthly on Grab Composites	Gross Alpha Tritium	1×10^{-7} 1×10^{-5}
		Quarterly on Grab Composites	Sr-89/90	5×10^{-8}
c. Waste Water Effluent	Continuous Composite[4]	Weekly	Gamma Emitters I-131	5×10^{-7} 1×10^{-6}
		Monthly on Weekly Composite	Gross Alpha Tritium	1×10^{-7} 1×10^{-5}
		Quarterly on Monthly Composite	Sr-89/90	5×10^{-8}

RADIOLOGICAL EFFLUENT CONTROL MANUAL

NOTES FOR TABLE 6-1

1. The principal gamma emitter for which the gamma isotopic LLD applies is Cs-137. Because gamma isotopic analyses are performed, the LLDs for all other gamma emitters are inherently determined by the operating characteristics of the counting system. All identifiable gamma emitters will be reported in the Annual Monitoring Report.

2. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and mixed to assure representative sampling.

3. A continuous release is the discharge of liquid wastes of a non-discrete volume; e.g., from a volume of a system that has an input flow during the release.

4. A continuous composite is one in which the method of sampling employed results in a specimen that is representative of the liquids released.

5. Identified entrained noble gases shall be reported as gaseous effluents.

RADIOLOGICAL EFFLUENT CONTROL MANUAL

TABLE 6-2
RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Level of Detection[1] (μCi/cc)
1. Gas Decay Tank	Prior to Release	Prior to Release	Gamma Emitters	1×10^{-4}
2. Containment Purge or Continuous Vent	Prior to Purge[2] or Vent	Prior to Purge or Vent	Gamma Emitters Tritium	1×10^{-4} 1×10^{-6}
3. Continuous Releases: a. Unit 1 Containment Purge and Vent b. Unit 2 Containment Purge and Vent c. Drumming Area Vent d. Gas Stripper Building Vent e. Auxiliary Building Vent	Continuous[3]	Weekly Analysis of Charcoal and Particulate Samples	Gamma Emitters I-131	1×10^{-11} 1×10^{-12}
		Monthly Composite of Particulate Sample	Gross Alpha	1×10^{-11}
		Quarterly Composite of Particulate Sample	Sr-89/90	1×10^{-11}
		Noble Gas Monitor	Noble gases Gross Beta or gamma	1×10^{-6}
	Monthly[4] (Grab)	Monthly	Gamma Emitters	1×10^{-4}
		Monthly	Tritium	1×10^{-6}

RADIOLOGICAL EFFLUENT CONTROL MANUAL

NOTES FOR TABLE 6-2

1. The principal gamma emitters for which the LLD specification applies are Cs-137 in particulates and Xe-133 in gases. Because gamma isotopic analyses are performed, the LLDs for all other gamma emitters are inherently determined by the operating characteristics of the counting system. All identifiable gamma emitters will be reported in the Annual Monitoring Report.

2. Tritium grab samples will be taken every 24 hours when the refueling cavity is flooded.

3. The ratio of the sample flow rate to the release flow rate shall be known or estimated for the time period covered by each sampling interval.

4. Tritium grab samples will be taken every seven days from the drumming area ventilation exhaust/spent fuel pool area whenever there is spent fuel in the spent fuel pool.