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WNP-2 SEMI-ANNUAL EFFLUENT

REPORT

JULY TO DECEMBER 1985

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

LICENSE NO. NPF-21

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1.0 INTRODUCTION

This report is submitted in compliance with Technical Specification 6.9.1.11. It includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from WNP-2 during the previous six months of operation with data summarized on a quarterly basis.

2.0 LIQUID EFFLUENTS

The radwaste liquid effluents were released in a batch mode only during the reporting period. Two batch releases occurred during the third calendar quarter and one batch release during the fourth calendar quarter. The total time period for the batch releases was 5.4 hours, with the maximum time period being 3.2 hours for a release, the minimum time period being 0.6 hours for a release and the average time period was 1.8 hours. The volume of dilution water used, is the total volume of recirculating cooling tower blowdown flow for the period. The average flow rate of the Columbia River during July through December 1985 was $9.1\text{E}+04$ cubic feet per second.

Periodic LADTAP II computer runs were performed to verify compliance with Technical Specification limits using the assumptions in the Offsite Dose Calculation Manual (ODCM).

The liquid batch releases were recirculated prior to sampling. A representative sample was obtained and analyzed for each batch release. The method for measurement of total radioactivity was by gamma spectroscopy, liquid scintillation and proportional counters.

The percent of MPC limit is based on the total MPC fractions using those nuclides in Table 2-2 and concentrations listed in 10CFR20, Appendix B, Table 2, Column 2.

The percent of estimated total errors are listed in Table 2-1. These estimated errors are based on counting statistics, tank volume, and in obtaining a representative sample prior to discharge.

The estimated total errors were calculated by obtaining the square root of the sum of the squares of the errors of the individual contributors and multiplying by 1.96 for a 95% confidence level.



Table 2-1

WNP-2 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

July - December 1985

Unit	3rd Quarter	4th Quarter	Est. Total Error* %
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A. Fission and activation products

1. Total release (not including tritium, gases, alpha)	Ci	4.1E-03	3.0E-03	2.2 E+01
2. Average diluted concentration during period	uCi/ml	5.6E-09	3.9E-09	
3. Percent of MPC limit	%	1.6E-02	6.6E-03	

B. Tritium

1. Total release	Ci	4.1E-01	1.9E-02	2.2 E+01
2. Average diluted concentration during period	uCi/ml	5.6E-07	2.5E-08	
3. Percent of MPC limit	%	1.9E-02	8.3E-04	

C. Gross alpha radioactivity

1. Total release	Ci	2.6E-07	5.1E-08	2.3 E+01
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D. Volume of waste (prior to dilution)	liters	1.8E+05	2.4E+04	1.5 E+01
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E. Volume of dilution water used during period	liters	7.3E+08	7.6E+08	1.5 E+01
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*At 95% confidence level



Table 2-2

WNP-2 LIQUID EFFLUENTS - SOURCE TERMS

July - December 1985

BATCH MODE

Nuclides Released	Unit	3rd Quarter	4th Quarter
Strontium-89	Ci	9.3 E-06	3.6 E-07
Strontium-90	Ci	7.4 E-06	2.9 E-07
Cesium-134	Ci	1.7 E-05	2.9 E-06
Cesium-137	Ci	1.8 E-05	2.8 E-06
Iodine-131	Ci	1.5 E-05	3.1 E-06

Cobalt-58	Ci	6.0 E-06	2.5 E-04
Cobalt-60	Ci	2.1 E-05	1.1 E-04
Iron-59	Ci	3.0 E-05	1.8 E-05
Zinc-65	Ci	3.7 E-05	2.4 E-04
Manganese-54	Ci	1.5 E-05	2.1 E-05
Chromium-51	Ci	1.4 E-04	8.6 E-04

Niobium-95	Ci	1.6 E-05	1.6 E-05
Molybdenum-99	Ci	1.4 E-05	1.3 E-05
Technetium-99m	Ci	1.9 E-05	2.0 E-05
Barium-lanthanum-140	Ci	4.8 E-05	9.8 E-06
Cerium-141	Ci	2.5 E-05	3.8 E-06



TABLE 2-2 (Continued)

Cerium-144	Ci	1.1 E-04	2.2 E-05
Tritium	Ci	4.1 E-01	1.9 E-02
Iron-55	Ci	3.1 E-05	1.2 E-06
Sodium-24	Ci	1.1 E-05	8.6 E-07
Copper-64	Ci	3.4 E-03	9.3 E-04
Arsenic-76	Ci	2.9 E-05	4.1 E-04
Tungsten-187	Ci	≈ 1.4 E-05	5.0 E-05
Antimony-122	Ci	≈ 4.3 E-06	1.0 E-05
Antimony-124	Ci	≈ 3.4 E-08	3.0 E-06
Silver-110m	Ci	1.6 E-05	3.9 E-06
Zirconium-95	Ci	2.2 E-05	9.3 E-06
Total for Period (Above)	Ci	4.1 E-01	2.2 E-02

3.0 GASEOUS EFFLUENTS

The gaseous radwaste effluents from WNP-2 were released in a continuous mode. There are three (3) release points at WNP-2:

1. Main Plant Vent - mixed mode release
2. Turbine Building - ground level release
3. Radwaste Building - ground level release

The gaseous source terms from each release point are listed in Tables 3-1 to 3-3. Table 3-4 provides a summation of the total activity released, the average release rate, the percent of Technical Specification limit, gross alpha radioactivity and the estimated total error associated with the measurements of radioactivity in the gaseous effluents.

Radioactivity measurements for gaseous effluent releases are performed for fission and activation gases by collecting the samples on charcoal traps and analyzing them using gamma spectroscopy. Tritium is sampled by freeze trapping and analyzed by liquid scintillation counting. Particulates and iodines are sampled using charcoal cartridges and particulate filters and analyzed using gamma spectroscopy.

The "Percent of Technical Specification Limit" calculations were based on exposure at specified locations. Air dose due to noble gases was determined at the site boundary with the quarterly limit of 5 mrad for gamma being the more restrictive for each time period. The gamma air dose from noble gases for the third quarter was $1.6\text{E-}02$ mrad and $2.1\text{E-}01$ mrad for the fourth quarter. Iodines, particulates and tritium calculations were determined at Taylor Flats, located 4.2 miles southeast. A limit of 7.5 mrems per quarter to any organ was used in these calculations. The maximum organ dose to a "Member of the Public" was $1.2\text{E-}02$ mrem for the third quarter and $7.9\text{E-}03$ mrem for the fourth quarter.

To verify compliance with Technical Specification limits, calculations were performed for each month's releases using the GASPAR computer program and parameters as outlined in the ODCM. Doses were determined at two special locations.

1. The Site Boundary at 1.2 miles from the plant and for the sector with the maximum X/Q value.
2. Taylor Flats - at 4.2 miles SE.

There were no abnormal releases of gaseous effluent during the third and fourth quarters of 1985. Sampling and monitoring of the gaseous effluents were performed in accordance with Technical Specifications and Plant Procedures.

Total error estimates are based on grab samples, gamma spectrometry, analyzer detectors, and beta scintillation readings. The overriding uncertainty in all cases is the measurement of the effluent and sample volumes. The estimated error was determined to be 36% at the 95% confidence level.

In addition to the reactor site, WNP-2 has a permanent laundry facility located approximately 0.75 miles from the site. Its ventilation system contains HEPA filters on the discharge and is continuously monitored for particulates and radioiodines. A total of $5.4\text{E-}01$ microcuries were released from the laundry facility during this reporting period. Gamma spectrometry indicated no isotopes present other than those attributable to natural background.



Table 3-1.

WNP-2 GASEOUS EFFLUENTS
SOURCE TERMS - MIXED MODE RELEASES
MAIN PLANT VENT

July - December 1985

CONTINUOUS MODE

Nuclides Released	Unit	3rd Quarter	4th Quarter
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1. Fission gases

Krypton-85	Ci	1.3 E-03	1.6 E-01
Krypton-85m	Ci	8.8 E-01	3.0 E+00
Krypton-87	Ci	5.5 E-01	8.1 E-01
Krypton-88	Ci	9.8 E-01	4.1 E+00
Xenon-133	Ci	6.9 E-01	2.7 E+00
Xenon-135	Ci	2.1 E-01	8.5 E-02
Xenon-135m	Ci	1.1 E-02	1.1 E-03
Xenon-138	Ci	3.3 E+00	2.7 E+00
Xenon-131m	Ci	1.3 E+00	1.9 E-01
Xenon-133m	Ci	9.8 E-01	1.2 E+00
Argon-41	Ci	9.9 E-03	2.1 E-07
Total for period	Ci	8.9 E+00	1.5 E+01

2. Iodines

Iodine-131	Ci	3.1 E-04	2.4 E-04
Iodine-133	Ci	2.2 E-03	2.3 E-03
Iodine-135	Ci	≤ 2.4 E-03	≤ 2.5 E-03
Total for period	Ci	4.9 E-03	5.0 E-03



Table 3-1 (Continued)

3. Particulates

Strontium-89	Ci	1.2 E-06	5.9 E-06
Strontium-90	Ci	3.1 E-07	1.8 E-06
Cesium-134	Ci	6.6 E-04	3.6 E-04
Cesium-137	Ci	5.8 E-04	3.3 E-04
Barium-lanthanum-140	Ci	2.2 E-03	1.2 E-03
Molybdenum-99	Ci	3.2 E-03	1.1 E-02
Cerium-141	Ci	6.2 E-04	3.3 E-04
Cerium-144	Ci	2.7 E-03	1.4 E-03
Cobalt-58	Ci	3.0 E-03	2.5 E-03
Cobalt-60	Ci	9.7 E-04	6.7 E-04
Chromium-51	Ci	5.9 E-03	3.8 E-03
Zinc-65	Ci	6.0 E-03	5.3 E-03
Zirconium-95	Ci	9.5 E-04	5.4 E-04
Iron-59	Ci	1.1 E-03	6.4 E-04
Manganese-54	Ci	1.8 E-02	3.8 E-04
Total for period	Ci	4.6 E-02	2.8 E-02

4. Tritium	Ci	2.9 E-01	1.4 E+00
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Total building release	Ci	9.2 E+00	1.6 E+01
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Table 3-2

WNP-2 GASEOUS EFFLUENTS
SOURCE TERMS GROUND LEVEL RELEASES
TURBINE BUILDING

July - December 1985

CONTINUOUS MODE

Nuclides Released	Unit	3rd Quarter	4th Quarter
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1. Fission gases

Krypton-85	Ci	$\leq 3.4 \text{ E}+00$	$3.1 \text{ E}+00$
Krypton-85m	Ci	$\leq 6.7 \text{ E}-01$	$1.3 \text{ E}-01$
Krypton-87	Ci	$2.3 \text{ E}+00$	$2.3 \text{ E}+00$
Krypton-88	Ci	$2.5 \text{ E}+00$	$2.3 \text{ E}+00$
Xenon-133	Ci	$3.1 \text{ E}+00$	$2.3 \text{ E}+00$
Xenon-135	Ci	$6.2 \text{ E}+00$	$1.4 \text{ E}+00$
Xenon-138	Ci	$6.8 \text{ E}+00$	$2.0 \text{ E}+01$
Xenon-133m	Ci	$6.5 \text{ E}+00$	$5.6 \text{ E}+00$
Xenon-135m	Ci	$2.7 \text{ E}+00$	$2.2 \text{ E}+00$
Total for period	Ci	$3.4 \text{ E}+01$	$3.9 \text{ E}+01$

2. Iodines

Iodine-131	Ci	$1.9 \text{ E}-04$	$1.3 \text{ E}-04$
Iodine-133	Ci	$1.1 \text{ E}-03$	$8.9 \text{ E}-04$
Iodine-135	Ci	$\leq 9.2 \text{ E}-03$	$\leq 9.1 \text{ E}-03$
Total for period	Ci	$1.0 \text{ E}-02$	$1.0 \text{ E}-02$

Table 3-2 (Continued)

3. Particulates

Strontium-89	Ci	1.6 E-05	4.1 E-06
Strontium-90	Ci	1.7 E-06	3.7 E-05
Cesium-134	Ci	1.1 E-03	4.2 E-04
Cesium-137	Ci	1.2 E-03	4.4 E-04
Barium-lanthanum-140	Ci	3.6 E-03	1.8 E-03
Cerium-141	Ci	1.3 E-03	4.9 E-04
Cerium-144	Ci	5.1 E-03	2.1 E-03
Cobalt-58	Ci	1.1 E-03	4.7 E-04
Molybdenum-99	Ci	4.7 E-03	4.6 E-03
Cobalt-60	Ci	1.4 E-03	5.4 E-04
Chromium-51	Ci	9.1 E-03	3.7 E-03
Zinc-65	Ci	2.7 E-03	1.1 E-03
Zirconium-95	Ci	1.9 E-03	7.6 E-04
Iron-59	Ci	2.4 E-03	1.2 E-03
Manganese-54	Ci	1.3 E-03	4.4 E-04
Total for period	Ci	3.7 E-02	1.8 E-02

4. Tritium	Ci	1.5 E+00	3.3 E+00
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Total building release	Ci	3.6 E+01	4.2 E+01
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Table 3-3

WNP-2 GASEOUS EFFLUENTS
SOURCE TERMS GROUND LEVEL RELEASES
RADWASTE BUILDING

July - December 1985

CONTINUOUS MODE

Nuclides Released	Unit	3rd Quarter	4th Quarter
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1. Fission gases

Krypton-85	Ci	2.2 E-01	1.7 E-01
Krypton-85m	Ci	2.2 E-01	5.2 E-02
Krypton-87	Ci	4.8 E-01	5.1 E-01
Krypton-88	Ci	6.5 E-01	6.2 E-01
Xenon-133	Ci	1.6 E+00	1.1 E+00
Xenon-135	Ci	3.1 E+00	9.7 E-01
Xenon-135m	Ci	1.7 E+00	2.0 E+00
Xenon-138	Ci	3.4 E+00	4.5 E+00
Xenon-133m	Ci	1.7 E+00	1.6 E+00
Xenon-137	Ci	1.5 E+01	1.7 E+00
Total for period	Ci	2.8 E+01	1.3 E+01

2. Iodines

Iodine-131	Ci	4.1 E-05	2.1 E-05
Iodine-133	Ci	1.6 E-04	1.2 E-04
Iodine-135	Ci	≤ 3.1 E-03	≤ 3.1 E-03
Total for period	Ci	3.3 E-03	3.2 E-03



Table 3-3 (Continued)

3. Particulates

Strontium-89	Ci	1.0 E-06	9.8 E-07
Strontium-90	Ci	2.4 E-06	2.6 E-06
Cesium-134	Ci	1.4 E-04	5.9 E-05
Cesium-137	Ci	1.2 E-04	5.3 E-05
Barium-Lanthanum-140	Ci	3.9 E-04	1.9 E-04
Molybdenum-99	Ci	3.5 E-04	5.6 E-04
Cerium-141	Ci	1.4 E-04	6.2 E-05
Cerium-144	Ci	5.5 E-04	2.5 E-04
Cobalt-58	Ci	1.2 E-04	5.6 E-05
Cobalt-60	Ci	3.4 E-04	1.5 E-04
Chromium-51	Ci	8.9 E-04	4.3 E-04
Zinc-65	Ci	2.8 E-04	1.3 E-04
Zirconium-95	Ci	1.9 E-04	9.0 E-05
Iron-59	Ci	3.1 E-04	2.4 E-04
Manganese-54	Ci	1.9 E-04	5.8 E-05
Total for period	Ci	4.0 E-03	2.3 E-03

4. Tritium	Ci	6.0 E-02	1.8 E-01
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Total building release	Ci	2.8 E+01	1.3 E+01
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Table 3-4

WNP-2 GASEOUS EFFLUENTS
SUMMATION OF ALL RELEASES

July - December 1985

Unit	3rd Quarter	4th Quarter	Est. Total Error %*
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A. Fission & activation gases

1. Total release	Ci	7.1 E+01	6.7 E+01	3.6 E+01
2. Average release rate for period	uCi/sec	8.9 E+00	8.4 E+00	
3. Percent of Tech. Spec. limit	%	3.2 E-01	4.2 E+00	

B. Iodines

1. Total iodine (131, 133)	Ci	1.8 E-02	1.8 E-02	3.6 E+01
2. Average release rate for period	uCi/sec	2.3 E-03	2.3 E-03	
3. Percent of Tech. Spec. limit	%	1.6 E-01	1.1 E-01	

C. Particulates

1. Particulates with half-lives 8 days	Ci	8.7 E-02	4.8 E-02	3.6 E+01
2. Average release rate for period	uCi/sec	1.1 E-02	6.0 E-03	
3. Percent of Tech. Spec. limit	%	1.6 E-01	1.1 E-01	
4. Gross alpha radioactivity	Ci	6.1 E-04	9.5 E-04	

D. Tritium

1. Total releases	Ci	1.9 E+00	4.9 E+00	3.6 E+01
2. Average release rate for period	uCi/sec	2.4 E-01	6.2 E-01	
3. Percent of Tech. Spec. limit	%	1.6 E-01	1.1 E-01	

* At 95% confidence level



Table 3-5

WNP-2 GASEOUS EFFLUENTS
BATCH RELEASES

July - December 1985

Type	Number	Total Time (hrs)	Maximum Time (hrs)	Minimum Time (hrs)	Mean Time (hrs)
Purge	2	17	9	8	8.5
Vent	123	217.5	5.5	0.3	1.8



4.0 SOLID WASTE

A total volume of 6432 ft³ (182 m³) of solid waste was transported in 21 shipments during the July 1 through December 31, 1985 reporting period. The total activity of the solid waste shipped was 100.4 Ci; 99.95 Ci contained in dewatered spent resins, 0.3529 Ci in Dry Active Waste (DAW) and 0.1380 Ci in absorbed oil.

A. Dewatered Spent Resin

Dewatered resins accounted for 3184 ft³ (90.2 m³) of the radioactive wastes shipped during the reporting period. The burial containers were CNS 14-195 steel liners provided by Chem-Nuclear Systems, Inc. The total activity of the resins shipped during the reporting period was 99.95 Ci. The principle nuclides and their percent contribution to the total activity are listed in Table 4-2. The solid wastes were shipped to the U.S. Ecology, Hanford burial site using flat bed trailers, CNS 14-195H, CNS 14-215H or NUPAC 14-210H casks as appropriate.

The counting error associated with the total activity of the ten principle nuclides (about 99.4% of the total activity shipped) is 0.63% at one standard deviation. Since the remaining nuclides represent such a small portion of the total activity shipped, their error contribution was neglected.

Other parameters considered in estimating the total error of the activity shipped included the error in measuring the absolute volume, the weight of the waste in the liners, the representativeness of the sample taken, the homogeneity of the nuclide distribution within a batch or liner and the geometry error in the gamma spectroscopy analysis. The gamma spectroscopy calibration error was approximately 5%. The best estimate of the total error in the activity of spent resin shipped was assumed to be less than or equal to 20%.

B. Dry Active Waste (DAW)

A total of 2520 ft³ (71.4 m³) of DAW was shipped in 28 container Products Corporation, B-25 steel boxes. The total activity of the DAW shipped was 0.3529 Ci. The values for the activities shipped were determined by using dose rate-to-curie conversion factors. The conversion factors were based on a nuclide distribution taken from reactor coolant sample analyses which are representative for the time period in which the waste was generated. Short lived nuclides were eliminated based on decay of the DAW prior to shipment. A meaningful counting error cannot be generated for the DAW, however, the total error may be assumed to be less than or equal to 20% since DAW would be subjected to similar error contributions as the spent resins.



C. Absorbed Liquids

A total of 727.9 ft³ (20.6 m³) of absorbed oil (or oily material) was shipped during the reporting period. About 6 gallons of oil was absorbed with diatomaceous earth in each of 99, 55 gallon Type 7A drums in order to meet burial ground requirements. The drums were of either a 17C, 17H or 17E/H designation but were shipped only as strong tight containers (STCs) per DOT requirements.

The values for the activities shipped were determined by using dose rate-to-curie conversion factors for the reported nuclides as described in paragraph B for DAW. As with the DAW, the total error is assumed to be less than or equal to 20% due to the likelihood of similar contributing errors to those associated with the resins.

4.1 Scaling Factor Methodology

H-3

In accordance with the procedure outlined in the AIF report "Methodologies for Classification of Low Level Radioactive Waste from Nuclear Power Plants", the amount of H-3 in solid radwaste shipments was determined by estimating or measuring the amount of water present and multiplying by the average H-3 concentration in the coolant for the time period associated with the waste generation. Dewatered resin samples were weighed and dried in an oven. It was found that the dewatered resin contained about 50% water by weight.

C-14

The generic scaling factor (C-14 to Co-60, 6.0 E-4) from the AIF report was used unless the results was less than 1.0E-6 uCi/g (typical MDA), in which case the MDA was used.

I-129

The I-129 concentration was determined by scaling to Cs-137. The Cs-137 MDA was used since Cs-137 was not detected, and the resulting value, if less than a typical I-129 MDA of 5.0E-7 uCi/g was reported as less than the MDA value. The scaling factor taken from the AIF report is 7.0E-5.

Tc-99

The Tc-99 concentration was determined by scaling to Cs-137. The Cs-137 MDA was used since Cs-137 was not detected, and the resulting value, if less than a typical Tc-99 MDA of 6.0E-8 uCi/g was reported as less than the MDA value. The scaling factor taken from the final AIF report is 9.0E-5.

1000

1000

1000

TRU, Sr-90, Ni-63

TRU nuclides were scaled to Ce-144. As recommended in the AIF report, these nuclides are not considered to be present if the scaled values are less than: 1 nCi/g for TRU, 35 nCi/g for Pu-241 or 200 nCi/g for Cm-242. During the reporting period the Ce-144 MDA was used to estimate the concentrations. Based on the scaling factors the calculated concentrations of TRUs, Pu-241 and Cm-242 were below the threshold values to report and were assumed not to be present.

Sr-90 is scaled to Cs-137 and Ni-63 is scaled to Co-60. The following table contains the scaling factors as reporting limits.

TABLE 4-1

Scaling Factors for TRU, Sr-90 and Ni-63

<u>Scaled Nuclide</u>	<u>Scaling Nuclide</u>	<u>Scaling Factor</u>	<u>Scaling Nuclide Reporting Limit</u>
Pu-238	Ce-144	7.5 E-3	1.33 E-1 uCi/g
Pu-239	Ce-144	5.0 E-3	2.00 E-1 uCi/g
Pu-241	Ce-144	5.5 E-1	6.36 E-2 uCi/g
Am-241	Ce-144	3.5 E-3	2.86 E-1 uCi/g
Cm-242	Ce-144	1.5 E-2	1.33 E+1 uCi/g
Cm-244	Ce-144	3.0 E-3	3.33 E-1 uCi/g
Ni-63	Co-60	2.0 E-2	Co-60 MDA uCi/g
Sr-90	Cs-137	1.0 E-2	4.0 E-2 uCi/g

4.2 Process Control Program

No substantial changes were initiated in Chem Nuclear's process Control Program during the last semi-annual reporting period.



Table 4-2
WNP-2 SOLID WASTE SHIPMENTS

July - December 1985

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL

1. Type of Waste

Waste Stream	Unit	6-month Period	Est. Total Error, %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m ³ Ci	90.2 99.95	20
b. Dry active waste, contaminated equip., etc.	m ³ Ci	71.4 0.3529	20
c. Irradiated components, control rods, etc.	m ³ Ci	No Ship- ment	
d. Other, absorbed liquids (oil)	m ³ Ci	20.6 0.1380	20

2. Estimate of major nuclide composition (by type of waste):

a. Dewatered Spent Resins

Nuclide	%	Ci
1 Zn-65	45.92	45.90
2 Co-58	24.64	24.63
3 Co-60	14.28	14.27
4 Cr-51	8.13	8.12
5 Mn-54	3.66	3.66
6 Zr-95	0.98	0.97
7 Fe-59	0.93	0.93
8 Nb-95	0.80	0.79
9 Co-57	0.08	0.08
10 Sb-124	0.03	0.03

b. Dry Active Wastes (DAW)

Nuclide	%	Ci
1 Zn-65	28.56	0.1008
2 Co-58	21.99	0.0776
3 Zr-95	18.49	0.0653
4 Cr-51	14.23	0.0502
5 Co-60	7.12	0.0251
6 Nb-95	5.32	0.0188
7 Mn-54	3.64	0.0128
8 Fe-59	0.15	5.46E-04

- c. Irradiated Components - None
- d. Other - Absorbed Liquids (oil)

Nuclide	%	Ci
1 Zn-65	27.33	0.0377
2 Co-58	18.75	0.0259
3 Zr-95	18.27	0.0252
4 Cr-51	12.91	0.0178
5 Co-60	6.38	0.0088
6 Nb-95	5.11	0.0071
7 Mn-54	3.46	0.0048

3. Solid Waste Disposition

<u>Number of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
21	Flat bed trailer (4) 14-195H Cask (13) 14-215H Cask (1) 14-210H Cask (3)	US Ecology Richland, WA

B. IRRADIATED FUEL SHIPMENTS (Disposition)

None



5.0 METEOROLOGY

The meteorological data contained in Tables 5-1 through 5-4 were obtained from the WNP-2 meteorological tower located 2500 ft. west of WNP-2. Data was recovered from 33 ft. and 245 ft. levels. The meteorological data is a composite file from both manual and automated data recovery systems.

The second half of 1985 started cooler and became cold and much drier than normal with a greater percentage of neutral and stable conditions affecting dispersion in the vicinity of WNP-2. The automated data recovery system continued to function at greater than 90% joint data recovery for the joint frequency parameters.

Tables 5-1 through 5-4 list the joint frequency distribution at the 33 ft. and 245 ft. levels for the third and fourth quarters. Additionally, this report includes Tables 5-5 through 5-6 which list the joint frequency distribution for all of 1985. The tabulated stability classes, A-G, are denoted by numerals 1-7 respectively. Numerals 1-7 were used for the wind subfields as is noted at the top of each sensor level reported. The 16 compass sectors in Tables 5-1 through 5-4 pertain to the direction the wind is coming from.

Calibrations performed in August-September 1985 produced no values exceeding WNP-2 FSAR meteorological equipment tolerances. Therefore, no correction has been made to the raw data. The NRC Delta Temperature Stability Classification scheme was utilized in the production of all joint frequency tables.

As mentioned in the previous report, some of the meteorological equipment has aged and must be replaced. An updated Climet Instruments, Inc. Delta-T system was replaced at the August-September calibration of the WNP-2 Meteorological Tower.

TABLE 5-1

THIRD QUARTER 1985 JOINT FREQUENCY DISTRIBUTION FOR THE 33 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	1.	0.	0.	0.	0.	0.	0.	0.	1.	2.	1.	0.	2.	1.	4.	0.
1	3	10.	7.	2.	0.	0.	0.	4.	9.	13.	11.	3.	5.	3.	0.	3.	4.
1	4	1.	3.	1.	1.	0.	0.	0.	9.	7.	4.	3.	2.	3.	1.	1.	3.
1	5	5.	1.	0.	0.	0.	0.	0.	0.	1.	3.	0.	7.	1.	0.	1.	0.
1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	0.
2	3	1.	1.	1.	0.	0.	0.	2.	5.	8.	2.	2.	1.	0.	0.	1.	4.
2	4	1.	0.	1.	0.	0.	1.	0.	0.	2.	4.	0.	1.	1.	0.	0.	2.
2	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	1.	0.	0.	0.	1.	0.	0.	1.	1.	0.	3.	1.	0.	0.	0.	0.
3	3	5.	2.	4.	0.	0.	1.	2.	9.	5.	1.	2.	1.	1.	0.	0.	2.
3	4	4.	0.	0.	1.	0.	2.	2.	3.	0.	2.	2.	1.	2.	1.	3.	3.
3	5	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	0.	1.	1.	1.	1.	0.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	2	8.	2.	6.	0.	0.	1.	1.	5.	1.	6.	1.	4.	6.	2.	5.	8.
4	3	36.	25.	4.	1.	1.	1.	6.	26.	36.	24.	9.	13.	9.	16.	12.	25.
4	4	19.	8.	3.	0.	0.	1.	1.	13.	11.	12.	8.	3.	3.	14.	14.	2.
4	5	0.	0.	0.	0.	0.	0.	0.	0.	2.	1.	1.	5.	0.	1.	5.	0.
4	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	2	12.	6.	6.	1.	1.	2.	4.	15.	11.	14.	10.	6.	8.	14.	12.	16.
5	3	23.	13.	16.	6.	8.	12.	33.	59.	43.	29.	17.	15.	10.	23.	28.	28.
5	4	2.	3.	0.	0.	0.	0.	1.	10.	19.	14.	7.	3.	6.	16.	13.	7.
5	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.	4.	2.	2.	12.	9.	0.
5	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	1	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.
6	2	5.	4.	6.	1.	4.	3.	6.	10.	6.	5.	3.	5.	10.	3.	9.	8.
6	3	7.	12.	8.	1.	0.	4.	13.	32.	30.	13.	7.	7.	4.	11.	18.	18.
6	4	0.	0.	1.	0.	0.	0.	0.	4.	7.	8.	0.	1.	4.	19.	9.	2.
6	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	1	1.	0.	0.	1.	0.	1.	0.	0.	0.	1.	1.	0.	0.	3.	0.	1.
7	2	25.	32.	17.	7.	0.	5.	12.	18.	12.	7.	10.	9.	9.	15.	12.	34.
7	3	12.	15.	22.	2.	0.	4.	10.	51.	32.	12.	2.	8.	3.	4.	16.	14.
7	4	0.	0.	0.	1.	0.	0.	0.	2.	0.	0.	0.	0.	1.	0.	1.	0.
7	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL NUMBER OF HOURS

USED = 2111 MISSING = 0 CALM = 5 VARIABLE = 53



TABLE 5-2

THIRD QUARTER 1985 JOINT FREQUENCY DISTRIBUTION FOR THE 245 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	4.	2.	3.	0.
1	3	13.	4.	1.	0.	0.	0.	2.	10.	11.	6.	3.	1.	0.	1.	2.	5.
1	4	2.	1.	1.	0.	0.	0.	2.	7.	10.	7.	4.	4.	3.	3.	1.	2.
1	5	5.	1.	0.	0.	0.	0.	0.	0.	2.	3.	2.	9.	1.	1.	0.	3.
1	6	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	1.	0.	0.	0.	0.	0.	0.	1.	0.	0.	1.	1.	0.	0.	0.	0.
2	3	4.	0.	0.	0.	0.	1.	2.	6.	3.	2.	1.	1.	0.	1.	0.	3.
2	4	0.	2.	0.	0.	0.	0.	0.	1.	5.	3.	1.	0.	1.	0.	0.	1.
2	5	1.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	1.	0.	1.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	1.	0.	0.	0.	0.	1.	0.	1.	0.	1.	4.	0.	0.	0.	0.	0.
3	3	2.	3.	2.	0.	0.	0.	3.	8.	2.	2.	1.	1.	0.	0.	1.	2.
3	4	4.	1.	0.	1.	0.	2.	3.	2.	3.	2.	2.	1.	1.	0.	0.	4.
3	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	1.	2.	1.	4.	2.	1.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	1.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	2	15.	0.	0.	0.	1.	0.	1.	4.	4.	1.	1.	2.	2.	4.	3.	4.
4	3	47.	34.	9.	5.	0.	1.	2.	15.	14.	24.	5.	11.	7.	7.	9.	21.
4	4	15.	22.	9.	0.	0.	2.	3.	5.	15.	11.	8.	4.	3.	8.	2.	6.
4	5	3.	4.	1.	0.	0.	0.	0.	3.	7.	4.	3.	6.	1.	19.	8.	1.
4	6	0.	0.	0.	0.	0.	0.	0.	0.	2.	1.	0.	2.	0.	2.	0.	0.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.
5	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	2	19.	4.	1.	1.	1.	0.	4.	8.	8.	14.	12.	9.	7.	9.	7.	7.
5	3	34.	27.	9.	3.	5.	14.	16.	27.	30.	31.	9.	8.	9.	15.	15.	22.
5	4	9.	17.	16.	11.	2.	3.	9.	16.	31.	15.	11.	6.	8.	9.	7.	14.
5	5	1.	0.	1.	2.	1.	1.	0.	0.	1.	9.	4.	0.	4.	19.	5.	3.
5	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.	3.	0.	17.	0.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	1.	1.	0.	0.
6	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	2	4.	5.	2.	2.	0.	1.	6.	6.	5.	4.	3.	2.	4.	5.	4.	3.
6	3	16.	12.	5.	3.	2.	3.	4.	11.	17.	10.	3.	3.	11.	9.	10.	8.
6	4	2.	4.	3.	6.	1.	1.	5.	9.	11.	10.	5.	1.	6.	19.	12.	6.
6	5	0.	0.	0.	4.	0.	0.	0.	0.	1.	7.	1.	0.	8.	26.	2.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	0.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.
7	2	18.	9.	11.	8.	2.	1.	2.	6.	8.	13.	7.	10.	8.	12.	8.	13.
7	3	28.	29.	9.	3.	4.	5.	12.	19.	24.	15.	12.	8.	4.	9.	20.	27.
7	4	1.	2.	4.	3.	0.	1.	4.	15.	21.	1.	1.	1.	4.	11.	16.	2.
7	5	0.	0.	0.	0.	0.	0.	0.	2.	0.	1.	0.	0.	0.	2.	1.	0.
7	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL NUMBER OF HOURS

USED = 2150

MISSING =

0

C-LN =

0

VARIABLE =

19



TABLE 5-3

FOURTH QUARTER 1985 JOINT FREQUENCY DISTRIBUTION FOR THE 33 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	4	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	3	0.	0.	0.	0.	0.	0.	0.	2.	1.	0.	0.	0.	0.	0.	0.	0.
3	4	0.	2.	2.	0.	0.	0.	0.	2.	9.	0.	0.	0.	0.	0.	0.	0.
3	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	5.	4.	1.	2.	0.	1.	0.	2.	1.	3.	0.	1.	1.	3.	2.	1.
4	2	22.	7.	4.	7.	8.	22.	24.	17.	21.	22.	15.	27.	26.	25.	26.	15.
4	3	13.	4.	1.	0.	2.	6.	13.	18.	13.	7.	5.	2.	9.	8.	8.	18.
4	4	5.	5.	4.	0.	0.	1.	2.	8.	18.	2.	2.	4.	4.	20.	4.	8.
4	5	1.	4.	1.	0.	0.	0.	0.	1.	9.	4.	3.	0.	0.	3.	0.	5.
4	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	0.	0.	0.	0.	0.	2.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	1	0.	0.	2.	0.	0.	3.	1.	2.	1.	0.	1.	0.	0.	4.	1.	2.
5	2	12.	10.	5.	1.	1.	12.	12.	12.	11.	22.	21.	36.	44.	31.	17.	9.
5	3	10.	5.	5.	0.	2.	13.	22.	28.	17.	7.	10.	25.	23.	44.	23.	26.
5	4	1.	0.	0.	1.	0.	0.	8.	18.	29.	8.	3.	9.	24.	28.	14.	4.
5	5	1.	1.	0.	0.	0.	0.	0.	1.	29.	15.	1.	0.	6.	5.	3.	3.
5	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	2.	2.	1.	0.
6	2	13.	6.	2.	3.	1.	2.	4.	4.	9.	11.	10.	14.	22.	20.	15.	9.
6	3	11.	6.	1.	0.	0.	3.	23.	33.	14.	7.	5.	7.	13.	21.	40.	16.
6	4	0.	0.	0.	0.	0.	0.	8.	9.	4.	1.	0.	2.	1.	1.	6.	0.
6	5	0.	0.	0.	0.	0.	0.	3.	0.	1.	0.	0.	0.	0.	0.	0.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	1	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.
7	2	12.	10.	4.	2.	1.	1.	4.	7.	10.	8.	6.	14.	14.	25.	24.	16.
7	3	8.	5.	0.	0.	0.	2.	9.	24.	13.	1.	3.	2.	5.	13.	8.	12.
7	4	0.	0.	0.	0.	0.	0.	0.	4.	1.	0.	0.	0.	0.	0.	0.	0.
7	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL NUMBER OF HOURS

USED = 1989 MISSING = 0 CALM = 4 VARIABLE = 28



TABLE 5-4

FOURTH QUARTER 1985

JOINT FREQUENCY DISTRIBUTION FOR THE 245 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	4	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.
3	4	0.	1.	4.	0.	0.	0.	0.	0.	5.	6.	0.	0.	0.	0.	0.	0.
3	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	0.	1.	0.	1.	0.	0.	0.	3.	1.	2.	0.	1.	3.	1.	2.	0.
4	2	26.	10.	5.	7.	2.	5.	5.	9.	16.	18.	26.	12.	19.	17.	18.	26.
4	3	28.	18.	3.	2.	0.	1.	3.	20.	17.	9.	9.	4.	3.	0.	8.	11.
4	4	3.	11.	15.	8.	1.	0.	0.	1.	5.	12.	4.	4.	2.	3.	11.	13.
4	5	3.	0.	0.	2.	8.	6.	0.	0.	0.	2.	3.	1.	0.	1.	0.	2.
4	6	0.	0.	0.	0.	0.	0.	4.	9.	3.	2.	4.	0.	0.	0.	0.	0.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	2.	1.	0.	0.	0.	0.	0.	0.
5	1	5.	1.	1.	0.	1.	0.	2.	0.	1.	1.	2.	0.	0.	2.	2.	0.
5	2	42.	8.	5.	3.	1.	5.	8.	3.	7.	9.	12.	11.	14.	17.	19.	10.
5	3	47.	44.	12.	5.	1.	0.	1.	10.	25.	19.	9.	1.	5.	8.	18.	31.
5	4	7.	6.	21.	16.	2.	0.	0.	6.	8.	9.	5.	1.	1.	12.	25.	31.
5	5	1.	0.	0.	8.	25.	11.	1.	2.	6.	15.	10.	1.	4.	10.	8.	3.
5	6	0.	0.	0.	0.	0.	1.	10.	17.	0.	11.	4.	0.	0.	0.	6.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	3.	1.	0.	0.	0.	0.	0.	0.
6	1	0.	0.	0.	0.	1.	0.	1.	2.	0.	0.	0.	1.	0.	0.	0.	1.
6	2	23.	6.	4.	2.	4.	2.	0.	7.	5.	6.	6.	9.	0.	7.	6.	6.
6	3	48.	14.	10.	5.	0.	0.	4.	10.	12.	9.	3.	5.	2.	4.	12.	13.
6	4	20.	7.	17.	11.	0.	0.	1.	9.	17.	8.	1.	0.	0.	4.	9.	10.
6	5	1.	0.	0.	7.	4.	0.	0.	0.	3.	3.	2.	0.	0.	4.	2.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	1	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	2	27.	5.	5.	3.	2.	2.	7.	4.	7.	3.	5.	3.	2.	0.	1.	2.
7	3	26.	18.	13.	3.	3.	0.	2.	12.	15.	11.	2.	3.	0.	2.	10.	25.
7	4	9.	2.	4.	3.	0.	0.	0.	10.	8.	1.	0.	0.	0.	0.	6.	3.
7	5	0.	0.	0.	1.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.
7	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL NUMBER OF HOURS

USED = 1939

MISSING =

0

CALM =

68

VARIABLE =

14



TABLE 5-5

1985 YEARLY JOINT FREQUENCY DISTRIBUTION FOR THE 33 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	1.	0.	0.	0.	0.	0.	0.	0.	1.	2.	2.	2.	3.	1.	5.	1.
1	3	10.	7.	2.	0.	0.	0.	4.	9.	13.	11.	4.	5.	3.	0.	3.	4.
1	4	1.	3.	1.	1.	0.	0.	0.	9.	7.	5.	3.	2.	3.	1.	1.	3.
1	5	5.	1.	0.	0.	0.	0.	0.	0.	1.	4.	1.	7.	1.	0.	1.	0.
1	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	1.	0.	1.	0.	0.	0.	0.	0.	0.	3.	3.	0.	0.	0.	0.	1.
2	3	2.	1.	1.	0.	0.	0.	2.	6.	8.	2.	2.	1.	0.	0.	1.	5.
2	4	1.	0.	2.	0.	0.	1.	0.	3.	3.	6.	0.	1.	1.	0.	0.	2.
2	5	4.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	1.	0.	0.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	4.	1.	0.	0.	1.	0.	1.	1.	3.	1.	3.	2.	0.	2.	4.	5.
3	3	8.	3.	4.	0.	0.	1.	2.	16.	7.	8.	4.	2.	2.	0.	0.	10.
3	4	6.	2.	2.	1.	0.	2.	2.	5.	11.	7.	4.	5.	4.	1.	4.	6.
3	5	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	4.	1.	1.	3.	2.	0.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	5.	4.	2.	3.	0.	1.	1.	2.	1.	4.	1.	3.	2.	5.	2.	3.
4	2	59.	20.	19.	11.	11.	25.	34.	28.	32.	44.	34.	44.	55.	52.	65.	45.
4	3	89.	51.	12.	2.	3.	11.	25.	52.	80.	56.	24.	24.	33.	46.	56.	95.
4	4	37.	16.	7.	0.	0.	4.	4.	26.	50.	37.	16.	16.	11.	41.	25.	17.
4	5	2.	4.	1.	0.	0.	0.	0.	1.	21.	8.	9.	6.	2.	8.	13.	9.
4	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	1.	2.	0.	0.	4.	3.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	2.	1.	1.	2.	0.
5	1	0.	0.	3.	1.	0.	3.	1.	3.	2.	0.	4.	1.	1.	5.	2.	7.
5	2	45.	32.	21.	4.	6.	21.	32.	46.	50.	54.	47.	63.	77.	91.	78.	60.
5	3	72.	60.	40.	10.	16.	38.	83.	159.	138.	100.	71.	94.	80.	120.	146.	122.
5	4	29.	14.	6.	4.	0.	0.	18.	55.	87.	87.	41.	34.	59.	76.	79.	50.
5	5	1.	1.	0.	0.	0.	0.	1.	4.	48.	38.	18.	12.	19.	39.	46.	3.
5	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	4.	5.	0.	3.	4.	3.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	0.	0.	0.	0.
6	1	1.	1.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	3.	3.	1.	0.
6	2	29.	20.	18.	7.	11.	11.	17.	31.	24.	30.	24.	33.	49.	40.	65.	39.
6	3	35.	33.	25.	7.	1.	10.	50.	101.	80.	38.	29.	39.	40.	68.	114.	82.
6	4	0.	1.	1.	4.	0.	0.	10.	50.	25.	16.	8.	8.	16.	65.	48.	13.
6	5	0.	0.	0.	0.	0.	0.	5.	3.	9.	6.	1.	1.	1.	9.	11.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	1.	0.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.
7	1	1.	0.	0.	1.	0.	1.	0.	0.	1.	1.	1.	0.	0.	3.	0.	1.
7	2	71.	64.	33.	16.	6.	7.	24.	44.	41.	35.	29.	37.	34.	60.	58.	76.
7	3	43.	43.	42.	14.	1.	9.	43.	142.	98.	38.	20.	25.	18.	39.	53.	57.
7	4	0.	1.	5.	1.	0.	0.	0.	23.	15.	7.	2.	2.	3.	8.	7.	0.
7	5	0.	0.	0.	0.	0.	0.	0.	1.	0.	2.	0.	0.	0.	0.	0.	0.
7	6	0.	0.	0.	0.	0.	0.	0.	0.	4.	2.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.

TOTAL NUMBER OF HOURS

USED = 8027

MISSING = 249

CALM = 10

VARIABLE = 158



TABLE 5-6

1985 YEARLY JOINT FREQUENCY DISTRIBUTION FOR THE 245 FT LEVEL
CALCULATED FROM HOURLY AVERAGES FROM TAPE

MAXIMUM WIND SPEEDS FOR EACH CATEGORY IN MPH ARE:

1 - 0.6 2 - 3.0 3 - 7.0 4 - 12.0 5 - 18.0 6 - 24.0

NUMBERS GIVEN ARE HOURS

STAB CLASS	WIND CAT	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	2	2.	0.	1.	0.	0.	0.	0.	0.	0.	1.	2.	3.	4.	2.	3.	0.
1	3	13.	4.	1.	0.	0.	0.	2.	10.	11.	6.	4.	1.	0.	1.	2.	5.
1	4	2.	1.	1.	0.	0.	0.	2.	7.	10.	8.	4.	4.	3.	3.	1.	2.
1	5	5.	1.	0.	0.	0.	0.	0.	0.	2.	4.	3.	9.	1.	1.	0.	3.
1	6	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	2	1.	1.	0.	0.	0.	0.	0.	2.	0.	1.	2.	3.	0.	0.	0.	2.
2	3	5.	0.	0.	0.	0.	1.	2.	6.	6.	2.	1.	1.	0.	1.	0.	4.
2	4	0.	2.	1.	0.	0.	0.	0.	2.	6.	4.	2.	0.	1.	0.	0.	1.
2	5	4.	0.	0.	0.	0.	0.	1.	0.	0.	1.	0.	0.	0.	1.	0.	2.
2	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	0.	0.
2	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.
3	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	2	2.	0.	0.	0.	0.	1.	0.	1.	1.	2.	4.	2.	0.	2.	5.	4.
3	3	6.	4.	2.	0.	0.	0.	3.	13.	3.	10.	5.	1.	1.	2.	2.	9.
3	4	4.	2.	4.	1.	0.	2.	3.	2.	10.	10.	2.	4.	3.	2.	0.	6.
3	5	1.	0.	0.	0.	0.	0.	0.	0.	0.	7.	5.	2.	1.	6.	2.	3.
3	6	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	3.	0.	0.	1.	0.	0.
3	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	1	2.	1.	0.	1.	1.	2.	0.	3.	3.	2.	0.	2.	3.	2.	2.	0.
4	2	60.	16.	11.	9.	3.	8.	18.	21.	38.	34.	41.	31.	41.	40.	49.	54.
4	3	117.	68.	25.	7.	0.	4.	8.	50.	50.	48.	24.	20.	25.	29.	58.	77.
4	4	38.	38.	24.	8.	1.	5.	4.	9.	37.	42.	19.	18.	8.	16.	25.	38.
4	5	6.	4.	1.	2.	8.	8.	1.	5.	20.	21.	11.	9.	3.	29.	11.	7.
4	6	0.	0.	0.	0.	0.	0.	4.	9.	8.	5.	7.	5.	1.	7.	4.	5.
4	7	0.	0.	0.	0.	0.	0.	0.	0.	3.	1.	3.	1.	0.	2.	1.	0.
5	1	5.	1.	1.	1.	2.	1.	3.	2.	4.	3.	2.	1.	1.	2.	2.	0.
5	2	77.	21.	12.	7.	6.	17.	25.	32.	42.	39.	41.	39.	38.	49.	52.	50.
5	3	127.	95.	33.	17.	13.	26.	50.	98.	121.	101.	48.	40.	46.	69.	128.	111.
5	4	42.	43.	41.	33.	6.	7.	23.	50.	102.	78.	58.	31.	31.	59.	74.	78.
5	5	7.	1.	1.	10.	26.	12.	1.	3.	27.	71.	30.	19.	29.	71.	40.	26.
5	6	0.	0.	0.	0.	0.	1.	10.	17.	1.	19.	19.	11.	8.	41.	11.	0.
5	7	0.	0.	0.	0.	0.	0.	0.	0.	9.	5.	11.	6.	3.	13.	0.	0.
6	1	0.	0.	0.	0.	1.	1.	1.	2.	1.	2.	1.	1.	0.	0.	0.	1.
6	2	34.	25.	12.	10.	10.	10.	14.	23.	17.	19.	17.	24.	13.	22.	17.	18.
6	3	75.	39.	28.	21.	7.	6.	16.	38.	61.	34.	16.	25.	32.	42.	56.	48.
6	4	24.	15.	23.	20.	2.	1.	19.	45.	57.	33.	13.	8.	24.	68.	54.	29.
6	5	3.	0.	0.	14.	4.	0.	3.	5.	12.	15.	8.	5.	17.	91.	16.	2.
6	6	0.	0.	0.	0.	0.	0.	0.	2.	5.	7.	1.	5.	9.	25.	1.	0.
6	7	0.	0.	0.	0.	0.	0.	0.	0.	3.	3.	2.	1.	1.	10.	0.	0.
7	1	1.	0.	0.	0.	0.	0.	0.	0.	2.	0.	1.	0.	0.	1.	0.	0.
7	2	53.	19.	22.	14.	7.	6.	15.	12.	26.	33.	26.	20.	20.	16.	20.	23.
7	3	76.	66.	35.	13.	13.	12.	25.	65.	81.	65.	39.	32.	13.	23.	54.	79.
7	4	12.	15.	13.	10.	2.	4.	8.	47.	62.	19.	9.	5.	15.	29.	44.	20.
7	5	1.	0.	4.	2.	0.	0.	3.	3.	5.	4.	3.	4.	6.	23.	13.	4.
7	6	0.	0.	0.	0.	0.	0.	0.	1.	2.	4.	0.	0.	2.	7.	6.	0.
7	7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.

TOTAL NUMBER OF HOURS

USED = 8053 MISSING = 249 CALA = 73 VARIABLE = 69

6.0 DOSE ASSESSMENT - IMPACT ON MAN

Liquid Effluents - The doses to the maximum individual from WNP-2 liquid effluents were calculated using the LADTAP II computer code and the site specific input parameters applicable to the reporting period (e.g., food production, agricultural productivity, etc.) The maximum exposed individual considered in the analysis was assumed to be an adult residing in Richland, who fishes at the WNP-2 slough area and eats food locally grown at the Riverview area district southwest of Pasco, Washington.

Table 6-1 lists the doses to the maximum individual during the third and the fourth quarters respectively. The liquid source terms used in the analyses are listed in Table 2-2 of this report.

The doses to the average exposed individual are listed in Table 6-2. The 50-mile population doses are listed in Table 6-3. All data was obtained from calculations using the LADTAP II computer code.

Gaseous Effluents - The GASPAR computer code was used to calculate doses at the 1.2 mile site boundary and Taylor Flats, located at 4.2 miles southeast. The sector with the highest X/Q values at the 1.2 mile location was used to verify compliance with Technical Specifications. The quarterly GASPAR runs utilized the quarterly averaged X/Q and D/Q values, and site specific input parameters pertaining to food productions (e.g., goat and cow grazing periods, etc.) The air doses at the site boundary were used to verify compliance with Technical Specification 3.11.2.2. To verify compliance with Technical Specification 3.11.2.3, the maximum organ dose to the maximum exposed individual located at Taylor Flats was evaluated. Table 6-4 lists the doses at these special locations.

6.1 Exposure to "A Member of the Public"

Two specific locations were evaluated for assessment of radiation doses to "Members of the Public", due to their activities within the site boundary. The two locations being the DOE Train and WNP-2 Visitor Center with the latter having the higher potential for exposure. The ODCM assumes an eight (8) hour per year occupancy by "A Member of the Public" at the Visitor Center. The dose assessment resulted in an annual calculated air dose due to noble gases of $1.5\text{E-}02$ mrad for gamma and $9.5\text{E-}03$ mrad for beta. The maximum annual organ dose was $1.1\text{E-}02$ mrem and the annual thyroid dose was $5.9\text{E-}03$ mrem.

The direct radiation contribution to a "Member of the Public" located at the WNP-2 Visitor Center was calculated to be $3.1\text{E-}01$ mrem. This result was obtained by using the quarterly mean of TLD stations 90, 91, and 92, which are located at the Protected Area fenceline. The quarterly mean was based on the average mR/day (24 hour), therefore the value is for a 8 hour stay time without credit for shielding.

Table 6-1

MAXIMUM INDIVIDUAL DOSES FROM WNP-2 LIQUID EFFLUENTS(1)

3RD AND 4TH QUARTERS 1985

Third Quarter 1985				
Pathway	Whole Body (mrem/qtr)	1985 Cumulative Whole Body (mrem/yr)	Max. Organ. (mrem/qtr)	1985 Cumulative Max. Organ. (mrem/yr)
Drinking	4.2E-07	2.7E-06	5.9E-07	5.8E-06
Shoreline	6.3E-08	4.4E-07	7.2E-08	4.5E-07
Fishing	6.7E-04	3.5E-03	1.0E-03	5.9E-03
Swimming	6.5E-10	2.1E-09	6.5E-10	2.1E-09
Boating	7.9E-10	2.6E-09	7.9E-10	2.6E-09
Leafy Veg.	8.3E-08	4.6E-07	2.2E-07	1.3E-06
Vegetables	5.6E-07	2.8E-06	1.0E-06	6.6E-06
Milk	9.8E-06	4.3E-05	1.2E-05	5.7E-05
Meat	3.7E-08	1.5E-07	1.0E-07	3.8E-07
Total	6.8E-04	3.6E-03	1.0E-03	6.0E-03

Fourth Quarter 1985				
Pathway	Whole Body (mrem/qtr)	1985 Cumulative Whole Body (mrem/yr)	Max. Organ. (mrem/qtr)	1985 Cumulative Max. Organ. (mrem/yr)
Drinking	4.2E-08	2.7E-06	1.6E-07	6.0E-06
Shoreline	1.9E-07	6.3E-07	2.2E-07	6.7E-07
Fishing	4.0E-04	3.9E-03	1.4E-03	7.3E-03
Swimming	8.6E-10	3.0E-09	8.6E-10	3.0E-09
Boating	1.1E-09	3.7E-09	1.1E-09	3.7E-09
Leafy Veg.	2.2E-08	4.6E-07	9.3E-08	1.3E-06
Vegetables	1.2E-08	2.8E-06	4.2E-07	6.6E-06
Milk	8.2E-06	5.1E-05	1.7E-05	7.4E-05
Meat	3.0E-08	1.8E-07	1.2E-07	5.0E-07
Total	4.1E-04	4.0E-03	1.4E-03	7.4E-03

(1) Age Group - Adult: Maximum individual resides at Richland and fishes at the WNP-2 slough area.



Table 6-2

AVERAGE INDIVIDUAL DOSES FROM WNP-2 LIQUID EFFLUENTS

3RD AND 4TH QUARTERS 1985

	Total per 3rd Quarter		Total per 4th Quarter	
Pathway	Max. Organ. (mrem)	Whole Body (mrem)	Max. Organ. (mrem)	Whole Body (mrem)
Fish	2.5E-06	1.7E-06	3.5E-06	1.0E-06
Drinking Water	3.4E-07	2.5E-07	9.1E-08	2.5E-08
Shoreline	2.5E-09	2.1E-09	7.4E-09	6.3E-09
Swimming	8.5E-11	8.5E-11	9.3E-11	9.3E-11
Boating	5.0E-11	5.0E-11	5.4E-11	5.4E-11
Vegetables	3.5E-06	1.6E-06	9.6E-07	3.8E-07
Leafy vegetables	3.4E-06	1.1E-06	9.9E-07	3.3E-07
Milk	7.4E-08	5.8E-08	1.1E-07	5.4E-08
Meat	<u>4.9E-08</u>	<u>2.0E-08</u>	<u>5.4E-08</u>	<u>1.8E-08</u>
Total	9.9E-06	4.7E-06	5.7E-06	1.9E-06

Table 6-3

50-MILE POPULATION DOSES FROM WNP-2 LIQUID EFFLUENTS

3RD AND 4TH QUARTERS 1985

	Total per 3rd Quarter		Total per 4th Quarter	
Pathway	Max. Organ. (man-rem)	Whole Body (man-rem)	Max. Organ. (man-rem)	Whole Body (man-rem)
Fish	1.5E-06	9.3E-07	1.8E-06	6.4E-07
Drinking water	1.9E-05	1.5E-05	4.6E-06	1.6E-06
Shoreline	8.2E-07	7.0E-07	2.4E-06	2.1E-06
Swimming	2.8E-08	2.8E-08	3.0E-08	3.0E-08
Boating	7.0E-09	7.0E-09	7.5E-09	7.5E-09
Vegetables	3.8E-05	1.8E-05	1.1E-05	4.2E-06
Leafy vegetables	3.7E-05	1.3E-05	1.1E-05	3.6E-06
Milk	1.1E-06	8.4E-07	1.6E-06	7.8E-07
Meat	<u>5.0E-07</u>	<u>2.0E-07</u>	<u>5.5E-07</u>	<u>1.8E-07</u>
Total	9.8E-05	4.9E-05	3.3E-05	1.3E-05



Table 6-4

SUMMARY OF DOSES FROM WNP-2 GASEOUS EFFLUENTS

3RD AND 4TH QUARTERS 1985

Location: 1.2 miles site boundaryReporting Period: Third and Fourth Quarters Plus Annual Cumulative, 1985

	<u>Third Quarter</u>	<u>Fourth Quarter</u>	<u>Annual Cumulative</u>
Beta air dose (mrad)*	1.7E-02	1.4E-01	2.1E-01
Gamma air dose (mrad)*	1.6E-02	2.1E-01	2.9E-01

Location: Taylor Flats, 4.2 miles SEReporting Period: Third and Fourth Quarters Plus Annual Cumulative, 1985

	<u>Third Quarter</u>	<u>Fourth Quarter</u>	<u>Annual Cumulative</u>
Maximum organ dose (mrem)**	1.2E-02	7.9E-03	4.2E-02

* Technical Specification 3.11.2.2.

** Technical Specification 3.11.2.3.

7.0 REVISIONS TO THE ODCM

During the semi-annual reporting period, revisions were made to the Offsite Dose Calculation Manual (ODCM), which are included under this section.



OFFSITE DOSE CALCULATION MANUAL

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2.0 LIQUID EFFLUENT DOSE CALCULATION

2.1 Introduction

Liquid radwaste released from WNP-2 will meet 10 CFR 20 limits at the point of discharge to the Columbia River. This design objective will be kept at all times. Based on the radionuclides mixture obtained from the WNP-2 GALE liquid computer run and Columbia River dilution flow, a theoretical, continuous concentration of radionuclides at 10 CFR 20 limits at the point of discharge to the Columbia River will result in compliance with 10 CFR 50 Appendix I limits in the unrestricted areas. Actual discharges of liquid radwaste effluents will only occur on a Batch Bases, and the average concentration at the point of discharge will be only a small percentage of the allowed limits.

The cumulative quarterly dose contributions due to radioactive liquid effluents released to the unrestricted areas will be determined once every 31 days using the LADTAP II computer code. The maximum exposed individual is assumed to be an adult whose exposure pathways include potable water and fish consumption. The choice of an adult as the maximum exposed individual is based on the highest fish and water consumption rates shown by that age group and the fact that most of the dose from the liquid effluent comes from these two pathways.

The dose contributions will be calculated for all radionuclides identified in the released effluent. The calculations are based on guidelines provided by the NRC Nureg-0133 and the LADTAP II computer code.

The methods for calculating the doses are discussed in Section 2.4 of this manual.

2.2 Radwaste Liquid Effluent Radiation Monitoring System

This monitoring subsystem measures the radioactivity in the liquid effluent prior to its entering the cooling tower blowdown line.



All radwaste effluent passes through a four-inch line which has an off-line sodium iodide radiation monitor. The radwaste effluent flow, variable from 0 to 190 gpm, combines with the 36-inch cooling water blowdown line, variable from 0 to 7500 gpm, (average of 2690 gpm) and is discharged to the Columbia River with a total flow based on MPC, total, and cooling water flushing needs.

The radiation monitor has a minimum sensitivity of 10^{-6} $\mu\text{Ci/cc}$ of Cs-137, and the radiation indicator has a range of seven decades. The radiation monitor is located on the 437' level of the Radwaste Building.

2.3 10 CFR 20 Release Rate Limits

The requirements pertaining to discharge of radwaste liquid effluents to the unrestricted area are specified in Technical Specification 3.11.1.1:

"The concentration of radioactive material released from the site to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than noble gases, and 2×10^{-4} $\mu\text{Ci/m}$ total activity concentration for all dissolved or entrained noble gases."

In order to comply with the requirements stated above, limits will be set to assure that blowdown line concentrations do not exceed 10 CFR 20, Appendix B, Table II, Column 2 at any time.

2.3.1 Pre-Release Calculation

The activity of the radionuclide mixture will be determined in accordance with Supply System procedure PPM 12.5.3, Liquid Effluent Discharge Determination. Liquid effluent discharge is determined and calculated according to PPM 12.11.1, Radiological Effluent Monitoring Gaseous and Liquid. The effluent concentration is determined by the following equation:

$$\text{Con}_{\text{Ci}} = \frac{\text{Ci} \times \text{fw}}{\text{rt}} \quad (1)$$



where:

Con_{Ci} = Concentration of radionuclide i in the effluent at point of discharge - $\mu Ci/ml$.

Ci = Concentration of radionuclide i in the batch to be released - $\mu Ci/ml$.

f_w = Discharge flow rate from sample tank to the blowdown line - variable from 0 to 190 gpm.

f_b = Blowdown flow rate - variable from 0 to 7500 gpm.

f_t = Total discharge flow rate - ($f_t = f_b + f_w$)

The calculated concentration in the blowdown line must be less than the concentrations listed in 10 CFR 20, Appendix B. Before releasing the batch to the environment, the following equation must hold:

$$\sum_{i=1}^m (Con_{Ci}/MPC_i) \leq 1 \quad (2)$$

where:

Con_{Ci} = The concentration of radionuclide i in the effluent at the point of discharge into the river.

MPC_i = Maximum permissible concentration of nuclide i as listed in 10 CFR 20, Appendix B, Table II.

m = Total number of radionuclides in the batch.

2.3.2 Post-Release Calculation

The concentration of each radionuclide in the restricted area, following the batch release, will be calculated as follows:

The average activity of radionuclide i during the time period of the release is divided by the Plant Discharge Flow/Tank Discharge Flow ratio yielding the concentration at the point of discharge:

$$Con_{Cik} = \frac{Cik \times fw}{ft} \quad (3)$$

where:

Con_{Cik} = The concentration of radionuclide i in the effluent at the point of discharge during the release period k - ($\mu Ci/ml$).

Cik = The concentration of radionuclide i in the batch during the release period k - ($\mu Ci/ml$).

fw = Discharge flow rate from sample tank to the blowdown line - variable from 0 to 190 gpm.

fb = Blowdown flow rate - variable from 0 to 7500 gpm.

ft = Total discharge ($ft = fb + fw$) flow rate - variable from 0 to 7690 gpm.

To assure compliance with 10 CFR 20, the following relationships must hold:

$$\sum_{i=1}^m (Con_{Cik}/MPC_i) \leq 1 \quad (4)$$

where the terms are as defined in Equation (2).

2.3.3 Continuous Release

Continuous release of liquid radwaste effluent is not planned for WNP-2. However, should it occur, the concentrations of various radionuclides in the



unrestricted area would be calculated according to Equation (3) and Equation (4). To show compliance with 10 CFR 20, the two equations must again hold.

2.4 10 CFR 50, Appendix I, Release Rate Limits

Technical Specification 4.11.1.2 requires that the cumulative dose contributions be determined in accordance with the ODCM at least once per 31 days. Technical Specification 3.11.1.2 specifies that the dose to a member of the public from radioactive material in liquid effluents released to the unrestricted area shall be limited to:

≤ 1.5 mrem/Calendar Quarter - Total Body
and
 ≤ 5.0 mrem/Calendar Quarter - Any Organ.

The cumulative dose for the calendar year shall be limited to:

≤ 3 mrem - Total Body
and
 ≤ 10 mrem - Any Organ.

The dose contribution will be calculated for all radionuclides identified in the liquid effluent released to the unrestricted area, using the following equation:

$$D_j = \sum_i (A_{ij} \sum_{\ell=1}^m T_{i\ell} C_{i\ell} F_{\ell}) \quad (5)$$

where:

D_j = The cumulative calendar quarter or yearly dose to any organ j from liquid effluent for the total release period - (in mrem).



- T_l = The length of the l th release period over which C_{il} and F_l are averaged for liquid releases - (in hours).
- m = The number of releases for the time period under consideration.
- C_{il} = Average concentration of nuclide i in the liquid effluent at point of discharge during the release period T_l from any liquid release - ($\mu\text{Ci/ml}$).
- A_{ij} = The site-related ingestion dose factor to the total body or critical organ j for each identified nuclide listed in Table 2-2 (in $\text{mrem/hr per } \mu\text{Ci/ml}$).
- F_l = The near field average dilution factor for C_{il} during any liquid waste release. Defined as the ratio of the average radwaste discharge flow during the release to the product of the average flow from the site structure to unrestricted receiving waters times 100. This is a conservative value since the average river flow is 120,000 cfs and blowdown rate is only 6 cfs.

$$(F_l = \frac{\text{Liquid Radwaste Flow}}{\text{Discharge Structure Exit} \times 100} = \frac{fw}{rt \times 100} \quad (6)$$

The term A_{ij} , the ingestion dose factors for the total body and critical organs, are tabulated in Table 2-2. It embodies the dose factor, fish bioaccumulation factor, pathway usage factor, and the dilution factor for the plant diffuser pipe to the nearest potable water intake. The following equation was used to calculate the ingestion dose factors:

$$A_{ij} = K_o \left(\frac{U_w}{D_w} + U_F B_{Fi} \right) D_{Fi} \quad (7)$$

where:

- A_{ij} = The composite dose parameter for total body or critical organ of an adult for nuclide i (in mrem/hr per $\mu\text{Ci/ml}$).
- K_o = A conversion factor:
 $1.14\text{E}+05 = \left[(10^6 \text{ pCi}/\mu\text{Ci}) \times (10^3 \text{ ml/liter}) \right] \div 8760 \text{ hr/yr.}$
- U_w = 730 liter/yr - which is the annual water consumption by the maximum adult (Table E-4 of Regulatory Guide 1.109, Revision 1).
- B_{Fi} = Bioaccumulation factor for radionuclide i in fish - (pCi/Kg per pCi/liter) (Table A-1 of Regulatory Guide 1.109, Revision 1).
- D_{Fi} = Adult ingestion dose conversion factor for nuclide i - Total body or critical organ - (mrem/pCi) (Table E-11 of Regulatory Guide 1.109, Revision 1).
- D_w = Dilution factor from near field area to the nearest potable water intake - 200.
- U_F = Adult fish consumption, 21 kg/yr (Table E-5 of Regulatory Guide 1.109, Revision 1).

The trip/alarm setpoint for the liquid radwaste effluent monitor is calculated from the results of the radiochemical analysis of the waste solution. The setpoint will be set into the radwaste monitor just prior to the release of each batch of radioactive liquid.

2.5.2 Methodology for Determining the Maximum Permissible Concentration (MPC) Fraction

Radwaste liquid effluents can only be discharged to the environment through the four-inch radwaste line. The maximum radwaste discharge flow rate is 190 gpm. Prior to discharge, the tank is isolated and recirculated for at least thirty minutes, and a representative sample is taken from the tank. An isotopic analysis of the batch will be made to determine the sum of the MPC fraction (MPC_f) based on 10 CFR 20 limits. From the sample analysis and the MPC values in 10 CFR 20, the MPC_f is determined using the following equation.

$$MPC_f = \sum_{i=1}^m \frac{C_i}{MPC_i} \quad (8)$$

where:

MPC_f = Total fraction of the Maximum Permissible Concentrations (MPCs) in the liquid effluent waste sample.

C_i = The concentration of each measured radionuclide (i) observed by the radiochemical analysis of the liquid waste sample ($\mu\text{Ci/ml}$).



MPC_i = The limiting concentrations of the appropriate radionuclide (i) from 10 CFR 20, Appendix B, Table II, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to $2.0E-04$ $\mu\text{Ci/ml}$ total activity.

m = The total number of measured radionuclides in the liquid batch to be released.

If the MCP_f is less than or equal to 0.8, the liquid batch may be released at any radwaste discharge or blowdown rate. If the MCP_f exceeds 0.8, then a dilution factor (F_d) must be determined. The liquid effluent radiation monitor responds proportionally to radioactivity concentrations in the undiluted waste stream. Its setpoint must be determined for diluted releases.

2.5.3 Methodology for the Determination of Liquid Effluent Monitor Setpoint

The measured radionuclide concentrations are used to calculate the dilution factor (F_d), which is the ratio of the total discharge flow rates ($f_w + f_b$) to the radwaste tank effluent flow rate (f_w) that is required to assure that the limiting concentrations of Technical Specification 3.11.1.1 are met at the point of discharge.

The dilution factor (F_d) is determined according to:

$$F_d = \left[\sum_{i=1}^m \frac{C_i}{MPC_i} \right] \times F_s \quad (9)$$

Where:

F_d = The dilution factor required for compliance with 10 CFR 20, Appendix B, Table II, Column 2.

- C_i = The concentration of each radionuclide (i) observed by radiochemical analysis of the liquid waste sample ($\mu\text{Ci/ml}$).
- MPC_i = The limiting concentration of the appropriate radionuclide (i) from 10 CFR 20, Appendix B, Table II, Column 2. For dissolved or entrained noble gases, the concentration shall be limited to $2.0\text{E-}04 \mu\text{Ci/ml}$ total activity.
- F_s = The safety factor; a conservative factor used to compensate for statistical fluctuations and errors in measurements. For example, a safety factor (F_s) of 1.5 corresponds to a fifty (50) percent (%) variation.
- m = The total number of measured radionuclides (i) in the liquid batch to be released.

The dilution which is required to ensure compliance with Technical Specification 3.11.1.1 concentration limits will be set such that discharge rates are:

$$F_d \leq \frac{f_w + f_b}{f_w} \quad (10)$$

and follows that:

$$f_w \leq \frac{f_b}{F_d - 1} \quad (10a)$$

or

$$f_b \geq f_w(F_d - 1) \quad (10b)$$

Where:

- F_d = The dilution factor from equation 9.



f_w = The discharge flow rate from the liquid radwaste tank to the blowdown line - variable from 0 to 190 gpm.

f_b = The cooling tower blowdown flow rate - variable from 0 to 7500 gpm.

The liquid effluent radiation monitor response is based on the results of the radiochemical analysis of the waste solution. Therefore the calculation for the radiation monitor's alarm/trip setpoint is;

$$SP = C + BK_g + K [C + Bk_g]^{1/2} \quad (11)$$

Where:

SP = Radiation monitor setpoint (count rate)

$C = \sum_{i=1}^m (C_i \times E_{fi})$ represents the count rate from the radionuclides in the liquid radwaste.

C_i = The concentration of each measured radionuclide (i) observed by radiochemical analysis of the liquid waste sample ($\mu Ci/ml$).

m = Same as for equation 9.

E_{fi} = The radwaste effluent monitor's response to radionuclide (i) (count rate per $\mu Ci/ml$).



BKg = Background count rate of the radwaste effluent monitor.

K = A constant to compensate for normal expected statistical variations in the liquid effluent radiation monitor count rate to reduce the chance of false alarms/trips; K=3.

2.6 Verification of Compliance with 10 CFR 50, Appendix I, and 10 CFR 20, Appendix B

Verification of compliance with 10 CFR 50, Appendix I, and 10 CFR 20, Appendix B, limits will be achieved by following WNP-2 Plant Procedures for liquid discharge and the periodic application of the LADTAP II computer code.

2.7 Methods for Calculating Doses to Man From Liquid Effluent Pathways

Dose models presented in NRC Regulatory Guide 1.109, Revision 1, as incorporated in the LADTAP II computer code, will be used for offsite dose calculation. The details of the computer code, including the program listing and user instruction, are included in the Radiological Programs Procedure R.P.I. 2.3, Offsite Dose Calculation Reference Manual -- LADTAP.

- d_i The deposition rate of nuclide i , in pCi/m^2 per hour.
- F The flow rate of the liquid effluent, in ft^3/sec .
- f_I The fraction of the year crops are irrigated, dimensionless.
- 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 $\text{pCi}/\text{liter (milk)}$ per pCi/day or $\text{pCi}/\text{kg (animal product)}$ per pCi/day .
- M_p The mixing ratio (reciprocal of the dilution factor) at the point of exposure (or the point of withdrawal of drinking water or point of harvest of aquatic food), dimensionless.
- P The effective "surface density" for soil, in $\text{kg (dry soil)}/\text{m}^2$ (Table E-1, Regulatory Guide 1.109, Revision 1).
- Q_{AW} The consumption rate of contaminated water by an animal, in liters/day .
- Q_F The consumption rate of contaminated feed or forage by an animal, in kg/day (wet weight).
- Q_i The release rate of nuclide i , in Ci/yr .
- r The fraction of deposited activity retained on crops, dimensionless (Table E-15, Regulatory Guide 1.109, Revision 1).



R_{apj}	The total annual dose to organ j of individuals of age group a from all of the nuclides i in pathway p , in mrem/yr.
t_b	The period of time for which sediment or soil is exposed to the contaminated water, in hours (Table E-15, Regulatory Guide 1.109, Revision 1).
t_e	The time period that crops are exposed to contamination during the growing season, in hours (Table E-15, Regulatory Guide 1.109, Revision 1).
t_h	A holdup time that represents the time interval between harvest and consumption of the food, in hours (Table E-15, Regulatory Guide 1.109, Revision 1).
T_i	The radioactive half life of nuclide i , in days.
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 ingestion of food or water, in hours (Table E-15, Regulatory Guide 1.109, Revision 1).
U_{ap}	A usage factor that specifies the exposure time or intake rate for an individual of age group a associated with pathway p , in hr/yr, ℓ /yr, or kg/yr (Table E-5, Regulatory Guide 1.109, Revision 1).



W	The shoreline width factor, dimensionless (Table A-2, Regulatory Guide 1.109, Revision 1).
Y_v	The agricultural productivity (yield), in kg (wet weight) /m ² (Table E-15, Regulatory Guide 1.109, Revision 1).
λ_{Ei}	The effective removal rate constant for radionuclide i from crops, in hr ⁻¹ , where $\lambda_{Ei} = \lambda_i + \lambda_w$, λ_i is the radioactive decay constant, and λ_w is the removal rate constant for physical loss by weathering (Regulatory Guide 1.109, Revision 1, Table B-15).
λ_i	The radioactive decay constant of nuclide i , in hr ⁻¹ .
1100	The factor to convert from (Ci/yr)/(ft ³ /sec) to pCi/liter.
110,000	The factor to convert from (Ci/yr)/(ft ³ /sec) to pCi/liter and to account for the proportionality constant used in the sediment radioactivity model.

These equations yield the dose rates to various organs of individuals from the exposure pathways mentioned above.

2.7.2 Plant Parameters

WNP-2 is a river shoreline site with a variable effluent discharge flow rate 0 to 7500 gpm (2690 gpm average). The population center nearest WNP-2 is the city of Richland, where drinking water withdrawal takes place. The applicable dilution factor is 20,000, using full river flow. The time required for re-



leased liquids to reach Richland, approximately 12 miles downstream, is estimated at 4.5 hours. Richland is the "realistic case" location, and doses calculated for the Richland location are typically applicable to the population as a whole. Individual and population doses based on Richland parameters are calculated for all exposure pathways.

Only the 75,000 population downstream of the WNP-2 site is affected by the liquid effluents released. There is no significant commercial fish harvest in the 50-mile radius region around WNP-2. Sportfish harvest is estimated at 14,000 kg/year.

For irrigated foods exposure pathways, it can be assumed that production within the 50-mile radius region around WNP-2 is sufficient to satisfy consumption requirements.

Other relevant parameters relating to the irrigated foods pathways are defined as follows:

<u>Food Type</u>	<u>Irrigation Rate</u> (liter/m ² /mo)	<u>Productivity</u> (kg/m ²)	<u>Growing Period</u> (Days)
Vegetation	150	5.0	70
Leafy Vegetation	200	1.5	70
Feed for Milk Cows	200	1.3	30
Feed for Beef Cattle	160	2.0	130

Source terms are measured based on sampled effluent.

Table 2-3 summarizes the LADTAP II input parameters. Documentation and/or calculations of these parameters are discussed in detail in R.P.I. 2.3, and Rad. Prog. calculation Log 83-1.

2.8 Compliance with Technical Specification 3.11.1.4

2.8.1 Maximum Allowable Liquid Radwaste Activity in Temporary Radwaste Hold-Up Tanks

The use of temporary liquid radwaste hold-up tanks is planned for WNP-2. Technical Specification 3.11.1.4 states the quantity of radioactive material contained in any outside temporary tanks shall be limited to the limits calculated in the ODCM such that a complete release of the tank contents would not result in a concentration at the nearest offsite potable water supply that would exceed the limits specified in 10 CFR Part 20 Appendix B, Table II.

Equation 18 will be used to calculate the curie limit for a temporary radwaste hold-up tank. The total tank concentration will be limited to less than or equal to ten (≤ 10) curies, excluding tritium and dissolved or entrained gases.

Surveillance requirement 4.11.1.4, states that the quantity of radioactive material in the hold-up tanks shall be determined to be within the limit by analyzing a representative sample of the tank's contents at least once per 7 days when radioactive materials are being added to the tank.

$$A_T = \frac{K_d}{\sum_i \frac{r_i}{MPC_i e^{\lambda_i t}}} \quad (18)$$

where:

A_T = Total allowed activity in tank (curies).

A_i = Activity of radioisotope i (curies).



- MPC_i = Maximum permissible concentration of radionuclide i
(10 CFR 20, Appendix B, Table II, Column 2).
- λ_i = Decay constant (years^{-1}) radioisotope i .
- t = Transit time of ground water from WNP-2 to WNP-1 well
(WNP-2 FSAR Section 2.4) = 67 years.
- f_i = Fraction of radioisotope $f_i = \frac{A_i}{\sum A_i}$.
- i = Index for all radioisotopes in tank except tritium
and noble gases.
- K_d = Dispersion constant based on hydrological parameters,
($2.4E+05$ Ci per $\mu\text{Ci/cc.}$)

The total allowed activity (A_T) is based on limiting WNP-1 well water to less than 1 MPC_i of the entire liquid content of the tank spilled to ground and then migrated via ground water to the WNP-1 well. The WNP-1 well is the location of maximum concentration since it is the nearest source of ground water and conditions are such that no spill of liquid should reach surface water. The 70-85 foot depth of the water table and the low ambient moisture of the soil requires a rather large volume of spillage for the liquid to even reach the water table in less than several hundred years. However, allowed tank activity (A_T) is conservatively based on all liquid radwaste in the tank instantaneously reaching the water table.

The hydrological analysis performed for the WNP-2 FSAR (Section 2.4) determined that the transit time through the ground water from WNP-2 to the WNP-1 well is 67 years for Strontium and 660 years for Cesium. These two radionuclides are representative of the radionuclides found in liquid radwaste. Strontium is a moderate sorber and Cesium strongly sorbs to soil particles. This calculation conservatively treats all radionuclides as moderate sorbers with a transit time of 67 years.

The concentration of each radionuclide in the well (CW_i) is simply the concentration in the tank (CT_i) adjusted for radioactive decay during transit ($e^{-\lambda t}$) and divided by the minimum concentration reduction factor (CRF_{min}). Limiting well concentration to 1 MPC yields:

$$\sum \frac{CW_i}{MPC_i} = 1 = \sum \frac{CT_i e^{-\lambda t}}{CRF_{min} MPC_i} \quad (\text{From section 2.4 of WNP-2 FSAR.}) \quad (19)$$

$$CRF_{min} = \frac{(4 \pi L)^{3/2} (a_x a_y a_z)^{1/2}}{2V} \quad (20)$$

where:

L = Migration distance = 1 mile.

V = Volume of tank.

a_x, a_y, a_z = Dispersion constants.

Combining Equations 19 and 20 yields:

$$1 = \sum \frac{CT_i \cdot 2V \cdot e^{-\lambda_i t}}{(4\pi L)^{3/2} (a_x a_y a_z)^{1/2} MPC_i} \quad (21)$$

Substituting A_i for $CT_i \cdot V$ and reorganizing terms yields:

$$\frac{(4\pi L)^{3/2} (a_x a_y a_z)^{1/2}}{2} = \sum \frac{A_i}{MPC_i \cdot e^{+\lambda_i t}} \quad (22)$$

Making the following substitutions

$$A_i = f_i AT$$

$$K_d = \frac{(4\pi L)^{3/2} (a_x a_y a_z)^{1/2}}{2} \times 10^{-6} \text{ Ci}/\mu\text{Ci} = 2.4 \times 10^5 \text{ Ci per } \frac{\mu\text{Ci}}{\text{cc}} \quad (23)$$



yields:

$$K_d = A_T \sum \frac{f_i}{MPC_i e^{+\lambda t}}$$

or

$$A_T = \sum \frac{\frac{K_d}{f_i}}{MPC_i e^{+\lambda t}} \quad (24)$$

2.8.2 Maximum Allowable Liquid Radwaste in Tanks That Are Not Surrounded by Liners, Dikes, or Walls

Although permanent outside liquid radwaste tanks which are not surrounded by liners, dikes, or walls are not planned for WNP-2, Equation 18 will be used should such tanks become necessary in the future.

2.9 Liquid Process Monitors and Alarm Setpoints Calculations

As mentioned in Section 2.2 of this manual, all liquid radwaste effluent is discharged through a four-inch line that is monitored by an off-line sodium iodide radiation monitor. This monitor is located on the 437' level of the Radwaste Building. All WNP-2 radwaste liquid effluent is discharged to the Columbia River through the 36-inch Cooling Water Blowdown line. In addition to the liquid effluent discharge monitor there are three liquid streams that are normally non-radioactive but have a finite possibility of having radioactive material injected into them. These liquid streams are:

- o Standby Service Water (SW)
- o Turbine Building Service Water (TSW)
- o Turbine Building Sump Water (FD)

To prevent any discharges of radioactive liquid from these streams, radiation monitoring systems have been installed to detect any increase above the normal background concentration of radioactive material.

Alarm/setpoints are established to prevent any release of radioactive material in concentrations greater than 10CFR20 limits. The maximum radiation detector setpoint calculation for the three systems is based on the MPC_i concentration of Cs-137 which is $2.0\text{E-}05 \mu\text{Ci/ml}$. The following equation is used to calculate the maximum setpoint:

$$\begin{array}{l} \text{Setpoint max.} = \left[(2.0\text{E-}05 \mu\text{Ci/ml}) (\text{CF}) \right] \\ \text{(in cpm or cps)} \end{array} \quad (25)$$

where:

$2.0\text{E-}05 \mu\text{Ci/ml}$ = MPC limit for Cs-137

CF = Monitor calibration factor - in cpm/ $\mu\text{Ci/ml}$ or cps/ $\mu\text{Ci/ml}$

2.9.1 Standby Service Water (SW) Monitor - The Standby Service Water Monitors (SW) are located on the 522' level of the Reactor Building.

The meter is located in the main control room on panel P-604.

The flow rate through the monitor is variable, from zero (0) to two (2) gpm with a normal flow of 1.0-1.5 gpm.

To ensure 10CFR20 limits are never exceeded, the alarm setpoint shall be established at 80% or less of the maximum setpoint plus background.

If the setpoint is exceeded, an alarm will activate in the main control room. The control room operator can then terminate the discharge and mitigate any uncontrolled release of radioactive material.

Table 2-1

FISH BIOACCUMULATION FACTORS (BF_i)⁽¹⁾
AND ADULT INGESTION DOSE CONVERSION FACTORS (DF_i)⁽²⁾

Nuclide	Fish Bioaccumulation Factor (BF _i) (pCi/kg per pCi/liter)	Dose Conversion Factor (DF _i)				
		Total Body	Bone	Thyroid	Liver	GI Tract
H-3	9.0E-01	1.1E-07	____(3)	1.1E-07	1.1E-07	1.1E-07
Na-24	1.0E+02	1.7E-06	1.7E-06	1.7E-06	1.7E-06	1.7E-06
P-32	1.0E+05	7.5E-06	1.9E-04	____(3)	1.2E-05	2.2E-05
Cr-51	2.0E+02	2.7E-09	____(3)	1.6E-09	____(3)	6.7E-07
Mn-54	4.0E+02	8.7E-07	____(3)	____(3)	4.6E-06	1.4E-05
Mn-56	4.0E+02	2.0E-08	____(3)	____(3)	1.2E-07	3.7E-06
Fe-55	1.0E+02	4.4E-07	2.8E-06	____(3)	1.9E-06	1.1E-06
Fe-59	1.0E+02	3.9E-06	4.3E-06	____(3)	1.0E-05	3.4E-05
Co-58	5.0E+01	1.7E-06	____(3)	____(3)	7.5E-07	1.5E-05
Co-60	5.0E+01	4.7E-06	____(3)	____(3)	2.1E-06	4.0E-05
Ni-65	1.0E+02	3.1E-08	5.3E-07	____(3)	6.9E-08	1.7E-06
Cu-64	5.0E+01	3.9E-08	____(3)	____(3)	8.3E-08	7.1E-06
Zn-65	2.0E+03	7.0E-06	4.8E-06	____(3)	1.5E-05	9.7E-06
Zn-69	2.0E+03	1.4E-09	1.0E-08	____(3)	2.0E-08	3.0E-09
Br-83	4.2E+02	4.0E-08	____(3)	____(3)	____(3)	5.8E-08
Br-84	4.2E+02	5.2E-08	____(3)	____(3)	____(3)	4.1E-13
Rb-89	2.0E+03	2.8E-08	____(3)	____(3)	4.0E-08	2.3E-21
Sr-89	3.0E+01	8.8E-06	3.1E-04	____(3)	____(3)	4.9E-05
Sr-90	3.0E+01	1.9E-03	7.6E-03	____(3)	____(3)	2.2E-04



Table 2-1 (contd.)

Nuclide	Fish Bioaccumulation Factor (BF _f) (pCi/kg per pCi/liter)	Dose Conversion Factor (DF _i)				
		Total Body	Bone	Thyroid	Liver	GI Tract
			(mRem	per pCi	Ingested)	
Sr-91	3.0E+01	2.3E-07	5.7E-06	(3)	(3)	2.7E-05
Sr-92	3.0E+01	9.3E-08	2.2E-06	(3)	(3)	4.3E-05
Y-90	2.5E+01	2.6E-10	9.7E-09	(3)	(3)	1.0E-04
Y-91m	2.5E+01	3.5E-12	9.1E-11	(3)	(3)	2.7E-10
Y-91	2.5E+01	3.8E-09	1.4E-07	(3)	(3)	7.8E-05
Y-92	2.5E+01	2.5E-11	8.5E-10	(3)	(3)	1.5E-05
Y-93	2.5E+01	7.4E-11	2.7E-09	(3)	(3)	8.5E-05
Mo-99	1.0E+01	8.2E-07	(3)	(3)	4.3E-06	1.0E-05
Tc-99m	1.5E+01	8.9E-09	2.5E-10	(3)	7.0E-10	4.1E-07
Tc-101	1.5E+01	3.6E-09	2.5E-10	(3)	3.7E-10	1.1E-21
Ru-103	1.0E+01	8.0E-08	1.9E-07	(3)	(3)	2.2E-05
Ru-105	1.0E+01	6.1E-09	1.5E-08	(3)	(3)	9.4E-06
Rh-105	1.0E+01	8.9E-08	1.2E-07	(3)	8.9E-08	9.1E-07
Te-129m	4.0E+02	1.8E-06	1.2E-05	4.0E-06	4.3E-06	5.8E-05
Te-129	4.0E+02	7.7E-09	3.1E-08	2.4E-08	1.2E-08	2.4E-08
Te-131m	4.0E+02	7.1E-07	1.7E-06	1.3E-06	8.5E-07	8.4E-05
Te-131	4.0E+02	6.2E-09	2.0E-08	1.6E-08	8.2E-09	2.8E-09
Te-132	4.0E+02	1.5E-06	2.5E-06	1.8E-06	1.6E-06	7.7E-05
I-131	1.5E+01	3.4E-06	4.2E-06	2.0E-03	6.0E-06	1.6E-06
I-132	1.5E+01	1.9E-05	2.0E-07	2.0E-05	5.4E-07	1.0E-07
I-133	1.5E+01	7.5E-07	1.4E-06	3.6E-04	2.5E-06	2.2E-06
I-134	1.5E+01	1.0E-07	1.0E-07	5.0E-06	2.9E-07	2.5E-10
I-135	1.5E+01	4.3E-07	4.4E-07	7.7E-05	1.2E-06	1.3E-06
Cs-134	2.0E+03	1.2E-04	6.2E-05	(3)	1.5E-04	2.6E-06
Cs-136	2.0E+03	1.9E-05	6.5E-06	(3)	2.6E-05	2.9E-06
Cs-137	2.0E+03	7.1E-05	8.0E-05	(3)	1.1E-04	2.1E-06
Cs-138	2.0E+03	5.4E-08	5.5E-08	(3)	1.1E-07	4.7E-13
Ba-139	4.0E+00	2.8E-09	9.7E-08	(3)	6.9E-11	1.7E-07



Table 2-1 (contd.)

Nuclide	Fish Bioaccumulation Factor (BF_i) (pCi/kg per pCi/liter)	Dose Conversion Factor (DF_i)				
		Total Body	Bone	Thyroid	Liver	GI Tract
			(mRem per pCi Ingested)			
Ba-140	4.0E+00	1.3E-06	2.0E-05	(3)	2.6E-08	4.2E-05
La-140	2.5E+01	3.3E-10	2.5E-09	(3)	1.3E-09	9.3E-05
La-141	2.5E+01	1.6E-11	3.2E-10	(3)	9.9E-11	1.2E-05
La-142	2.5E+01	1.5E-11	1.3E-10	(3)	5.8E-11	4.3E-07
Ce-141	1.0E+00	7.2E-10	9.4E-09	(3)	6.3E-09	2.4E-05
Ce-143	1.0E+00	1.4E-10	1.7E-09	(3)	1.2E-06	4.6E-05
Pr-143	2.5E+01	4.6E-10	9.2E-09	(3)	3.7E-09	4.0E-05
N-187	1.2E+03	3.0E-08	1.0E-07	(3)	8.6E-08	2.8E-05
Np-239	1.0E+01	6.5E-11	1.2E-09	(3)	1.2E-10	2.4E-05

(1) NRC Regulatory Guide 1.109, Revision 1, Table A-1.

(2) NRC Regulatory Guide 1.109, Revision 1, Table E-11.

(3) No data listed in Regulatory Guide 1.109, Revision 1, Table E-11.
(Use whole body dose conversion factor as an approximation.)

Table 2-2

INGESTION DOSE FACTORS (A_{ij}) FOR TOTAL BODY AND CRITICAL ORGAN
(in mrem/hr per $\mu\text{Ci/ml}$)

Nuclide	Liquid Effluent*				
	Total Body	Bone	Thyroid	Liver	GI Tract
H-3	2.8E-01	**	2.8E-01	2.8E-01	2.8E-01
Na-24	4.1E+02	4.1E+02	4.1E+02	4.1E+02	4.1E+02
P-32	1.8E+06	4.6E+07	**	2.9E+07	5.3E+06
Cr-51	1.3E+00	**	7.7E-01	**	3.2E+02
Mn-54	8.3E+02	**	**	4.4E+03	1.3E+04
Mn-56	1.9E+01	**	**	1.2E+02	3.6E+03
Fe-55	1.1E+02	6.7E+02	**	4.6E+02	2.6E+02
Fe-59	9.4E+02	1.0E+03	**	2.4E+03	8.2E+03
Co-58	2.0E+02	**	**	9.0E+01	1.8E+03
Co-60	5.7E+02	**	**	2.5E+02	4.8E+03
Ni-65	7.4E+00	1.3E+02	**	1.7E+01	4.1E+02
Cu-64	4.7E+00	**	**	1.0E+01	8.5E+02
Zn-65	3.4E+04	2.3E+05	**	7.2E+04	4.7E+04
Zn-69	6.7E+00	4.8E+01	**	9.65+01	1.4E+01
Br-83	4.0E+01	**	**	**	5.8E+01
Br-84	5.2E+01	**	**	**	4.1E-04
Rb-89	1.3E+02	**	**	1.9E+02	1.1E-10
Sr-89	6.4E+02	2.3E+04	**	**	3.5E+03
Sr-90	1.4E+05	5.5E+05	**	**	1.6E+04
Sr-91	1.7E+01	4.1E+02	**	**	2.0E+03
Sr-92	6.7E+00	1.6E+02	**	**	3.1E+03



Table 2-2 (contd.)

<u>Nuclide</u>	<u>Total Body</u>	<u>Bone</u>	<u>Thyroid</u>	<u>Liver</u>	<u>Gi Tract</u>
Ce-143	3.9E-04	4.8E-03	**	3.4E+00	1.3E+02
Pr-143	2.8E-02	5.5E-01	**	2.2E-01	2.4E+03
W-187	8.6E+01	2.9E+02	**	2.5E+02	8.0E+04
Np-239	1.6E-03	2.9E-02	**	2.9E-03	5.8E+02

*Based on conservative radionuclide mix obtained from GALE Liquid Code. Equation (7) was used to calculate the ingestion dose factors (A_{ij}).

**No Ingestion Dose Factor (DF_i) is listed in Table E-11 of Regulatory Guide 1.109, Revision 1. (Whole body dose factor value will be used as an approximation.)

All other locations listed in Figure 3-1 support WNP-2 activities and are controlled by the Supply System.

Air doses and doses to individuals at these locations were calculated based on the NRC GALE code design base mixture, location specific estimated occupancy, and X/Qs from XOQDOQ. (Note: Desert Sigmas were used in calculating X/Q and D/Q values, and are listed in Table 3-10 to 3-12). These doses are listed in Tables 3-16 and 3-17 along with the doses to the maximum exposed individual. The maximum exposed individual is considered to be residing in Taylor Flats (4.2 miles SE of WNP-2). This is the closest residential area with the highest X/Q and D/Q values.

3.2 Gaseous Effluent Radiation Monitoring System

3.2.1 Main Plant Release Point

The Main Plant Release is instrument monitored for gaseous radioactivity prior to discharge to the environment via the main plant vent release point. Particulates and iodine activity are accumulated in filters which will be changed and analyzed as per Technical Specification 4.11.2.1.2 and Table 4.11.2. The effluent is supplied from: the gland seal exhaust, mechanical vacuum pumps, treated off gas, standby gas treatment, and exhaust air from the entire reactor building's ventilation.

Two 100-percent capacity vanaxial fans supply 98,000 CFM ventilation air. One is normally operating, the other is in standby. The radiation monitors are located on the ventilation exhaust plenum.

Effluent monitoring consists of beta scintillators and two ion chamber LOCA monitors. The beta scintillator has a four inch thick lead shielded chamber and has an approximate response of 80 cpm/pCi/cc to Kr-85, and 50 cpm/pCi/cc to Xe-133.

The read out meter and recorder are located in the main control room panel BD-RAD-24. The analogue count rate meter has a range of $10\text{--}10^6$ cpm. Power

is provided from 125 VDC divisional buses. This monitor has no control function but annunciates in the main control room. The alarm will initiate proper action as defined in the WNP-2 Plant Procedures.

3.2.2 Radwaste Building Ventilation Exhaust Monitor

The radwaste building ventilation exhaust monitoring system monitors the radioactivity in the exhaust air prior to discharge. Radioactivity can originate from: radwaste tank vents, laboratory hoods, and various cubicles housing liquid process treatment equipment and systems.

The radwaste building exhaust system has three 50 percent capacity exhaust filter units of 42,000 cfm capacity. Each exhaust unit has a medium-efficiency prefilter, a high efficiency particulate air filter (HEPA) and two centrifugal fans. Total exhaust flow will vary as the combined exhaust unit maintains a radwaste building differential pressure of -0.25 inches H_2O to the environment.

Particulate and iodine air sample filters are changed weekly for laboratory analysis. After the particulate and iodine filters, the air sample streams are combined in a manifold prior to being monitored by a beta scintillator.

The beta scintillator, on radwaste 487' level southwest corner is mounted in a three inch lead shielded chamber and has an approximate response of 80 cpm/pCi/cc to Kr-85, and 50 cpm/pCi/cc to Xe-133. The readout meter and recorder are located in the main control room panel BD-RAD-24. The analog count rate meter has a range of 10 to 10^6 cpm. Power is provided from 125 VDC divisional buses. This monitor has no control functions but annunciates in the main control room. The alarm will initiate proper action as defined in the WNP-2 plant procedures.



3.2.3 Turbine Building Ventilation Exhaust Monitor

This monitoring system detects fission and the activation products from the turbine building air which may be present due to leaks from the turbine and other primary components in the building.

The turbine building main exhaust system consists of four roof-mounted centrifugal fans which draw air from a central exhaust plenum. Three fans operate continuously, with one in standby to provide a flow of 260,000 cfm.

A representative sample is extracted from the exhaust vent and passed through a particulate and charcoal filter. The air sample then passes to a beta scintillator.

The beta scintillator is mounted in a three inch lead shielded chamber and has an approximate response of 80 cpm/pCi/cc to Kr-85, and 50 cpm/pCi/cc to Xe-133. The monitor is on the 525' level of the radwaste building and the readout meter and the recorder are located in the main control room panel BD-RAD-24. The analog count rate meter has a range of 10 to 10^6 cpm. Power is provided from the 125 VDC divisional buses. This monitor has no control functions but annunciates in the main control room. The alarm will initiate proper action as defined in the WNP-2 plant procedures.

3.3 10 CFR 20 Release Rate Limits

Limits for release of airborne effluents to the unrestricted area are stated in Technical Specification 3.11.2.1. The dose rate in unrestricted areas due to radioactive materials released in gaseous effluents from the site shall be limited to the following values:

- (a) "The dose rate limit for noble gases shall be ≤ 500 mrem/yr to the total body and ≤ 3000 mrem/yr to the skin.
- (b) "The dose rate limit for all radioiodines and for all radioactive materials in particulate form and radionuclides other than noble gases with half-lives greater than eight days shall be ≤ 1500 mrem/yr to any organ."

3.3.1 Noble Gases

In order to comply with Technical Specification 3.11.2.1, the following equations must hold:

Whole body:

$$\sum_i^m K_i \left[(\overline{X/Q})_m \dot{Q}_{im} + (\overline{X/Q})_g \dot{Q}_{ig} \right] \leq 500 \text{ mrem/yr} \quad (1)$$

Skin

$$\sum_i^m \left[(L_i + 1.1M_i) ((\overline{X/Q})_m \dot{Q}_{im} + (\overline{X/Q})_g \dot{Q}_{ig}) \right] \leq 3000 \text{ mrem/yr} \quad (2)$$

3.3.2 Radioiodines and Particulates

Part "b" of Technical Specification 3.11.2.1 requires that the release rate limit for all radioiodines and radioactive materials in particulate form and radionuclides other than noble gases must meet the following relationship:

Any organ:

$$\sum_i^m P_i \left[W_M \dot{Q}_{im} + W_g \dot{Q}_{ig} \right] \leq 1500 \text{ mrem/yr} \quad (3)$$

The terms used in equations 1 through 3 are defined as follows:

K_i = The total body factor due to gamma emissions for each identified noble gas radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$).

L_i = The skin dose factor due to beta emissions for each identified noble gas radionuclide i (mrem/yr per $\mu\text{Ci}/\text{m}^3$).

- M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide in mrad/yr per $\mu\text{Ci}/\text{m}^3$ (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).
- P_i = The dose parameter for all radionuclides other than noble gases for the inhalation pathway, (mrem/yr per $\mu\text{Ci}/\text{m}^3$) and for food and ground plane pathways, m^2 (mrem/yr per $\mu\text{Ci}/\text{sec}$). The dose factors are based on the critical individual organ and the most restrictive age group.
- \dot{Q}_{im} = The release rate of radionuclide i in gaseous effluent from mixed mode release. The main plant release point is a partially elevated mixed mode release ($\mu\text{Ci}/\text{sec}$).
- \dot{Q}_{ig} = The release rate of radionuclide i in gaseous effluent from all ground level releases ($\mu\text{Ci}/\text{sec}$).
- $(\overline{X/Q})_m$ = (sec/m^3). For partially elevated mixed mode releases from the main plant vent release point. The highest calculated partially elevated annual average relative concentration for any area at or beyond the site boundary.
- $(\overline{X/Q})_g$ = (sec/m^3). For all Turbine Building and Radwaste releases. The highest calculated ground level annual average relative concentration for any area at or beyond the site boundary.



W_g = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to all ground level releases.

W_g = (sec/m^3) . For the inhalation pathway. The location is the site boundary in the sector of maximum concentration. .

W_g = m^{-2} . For ground plane pathways. The location is the site boundary in the sector of maximum concentration.

W_M = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to partially elevated releases:

W_M = sec/m^3 . For inhalation pathway. The location is the site boundary in the sector of maximum concentration.

W_M = m^{-2} . For ground plane pathways. The location is the site boundary in the sector of maximum concentration.

The factors, L_i and M_i , relate the radionuclide airborne concentrations to various dose rates assuming a semi-infinite cloud. These factors are listed in Table B-1 of Regulatory Guide 1.109, Revision 1, and in Table 3-1 of this manual.

The X/Q values used in the equations for the implementation of Technical Specification 3.11.2.1 are based upon the maximum long-term annual average at the site boundary. The distances between the nearest unrestricted area and the WNP-2 site are listed in Table 3-2. The distances between WNP-2 and the nearest vegetable garden, milk cow, and beef animal are tabulated in Table 3-3, along with representative X/Q and D/Q values.

The X/Q and D/Q values listed in Tables 3-10 through 3-12 reflect correct acquired meteorological data up to 1983 and were utilized in the initial GASPAR Computer runs. Subsequent reports will use updated X/Q and D/Q averages. Characteristics of WNP-2 gaseous effluent release points are listed in Table 3-13.

3.3.2.1 Dose Parameter for Radionuclide i (P_i)

The dose parameters used in Equation 3 are based on:

1. Inhalation and ground plane. (Note: Food pathway is not applicable to WNP-2 since no food is grown at or near the restricted area boundary.)
2. The annual average continuous release meteorology at the site boundary.
3. The critical organ for each radionuclide (thyroid for radioiodine).
4. The most restrictive age group.

Calculation of P_i^I (Inhalation): The following equation will be used to calculate P_i^I (Inhalation).

$$P_i^I \text{ (Inhalation)} = K^A(BR) DFA_i \text{ (mrem/yr per } \mu\text{Ci/m}^3\text{)} \quad (5)$$



where:

K^A = A constant of conversion, 10^6 pCi/ μ Ci.

BR = The breathing rate of the child age group, 3700 m³/yr.

DFA_i = The critical organ inhalation dose factor for the child age group for the i th radionuclide in mrem/pCi. The total body is considered as an organ in the selection of DFA_i .

The inhalation dose factor for DFA_i for the child age group is listed in Table E-9 of Regulatory Guide 1.109, Revision 1, and Table 3-4 of this manual. Resolving the units yields:

$$P_i^I = (\text{Inhalation}) = (3.7 \times 10^9)(DFA_i) (\text{mrem/yr per } \mu\text{Ci/m}^3) \quad (6)$$

The P_i^I (Inhalation) values for the child age group are tabulated in Table 3-4 of this manual.

3.4 10 CFR 50 Release Rate Limits

The requirements pertaining to 10 CFR 50 release rate limits are specified in Technical Specifications 3.11.2.2 and 3.11.2.3.

Technical Specification 3.11.2.2 deals with the air dose from noble gases and requires that the air dose at or beyond the site boundary due to noble gases released in gaseous effluents shall be limited to the following:

- (a) "During any calendar quarter, to ≤ 5 mrad for gamma radiation and to ≤ 10 mrad for beta radiation."
- (b) "During any calendar year, to ≤ 10 mrad for gamma radiation and ≤ 20 mrad for beta radiation."



Technical Specification 3.11.2.3 deals with radioiodines and radioactive materials in particulate form, and requires that the dose to an individual from radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases with half-lives greater than eight days in gaseous effluents released to unrestricted areas shall be limited to the following:

- (a) "During any calendar quarter, to ≤ 7.5 mrem."
- (b) "During any calendar year, to ≤ 15 mrem."

3.4.1 Noble Gases (Technical Specification 3.11.2.2)

The air dose at or beyond the site boundary due to noble gases released in the gaseous effluent will be determined by using the following equations.

- a. During any calendar quarter, for gamma radiation:

$$3.17 \times 10^{-8} \sum_i M_i \left[(\overline{X/Q})_g Q_{ig} + (X/q)_g q_{ig} + (\overline{X/Q})_m Q_{im} + (X/q)_m q_{im} \right] \leq 5 \text{ mrad (8)}$$

During any calendar quarter, for beta radiation:

$$3.17 \times 10^{-8} \sum_i N_i \left[(\overline{X/Q})_g Q_{ig} + (X/q)_g q_{ig} + (\overline{X/Q})_m Q_{im} + (X/q)_m q_{im} \right] \leq 10 \text{ mrad (9)}$$

- b. During any calendar year, for gamma radiation:

$$3.17 \times 10^{-8} \sum_i M_i \left[(\overline{X/Q})_g Q_{ig} + (X/q)_g q_{ig} + (\overline{X/Q})_m Q_{im} + (X/q)_m q_{im} \right] \leq 10 \text{ mrad (10)}$$



During any calendar year, for beta radiation:

$$3.17 \times 10^{-8} \sum_i N_i \left[(\overline{X/Q})_g Q_{ig} + (X/q)_g q_{ig} + (\overline{X/Q})_m Q_{im} + (X/q)_m q_{im} \right] \leq 20 \text{ mrad (11)}$$

where:

M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu\text{Ci}/\text{m}^3$ (M_i values are listed in Table 3-1).

N_i = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu\text{Ci}/\text{m}^3$ (N_i values are listed in Table 3-1).

$(\overline{X/Q})_g$ = For ground level release points. The highest calculated annual average relative concentration for area at or beyond the site area boundary for long-term releases (greater than 500 hr/yr). (Sec/m^3)

$(X/q)_g$ = For ground level release points. The relative concentration for areas at or beyond the site area boundary for short-term releases (equal to or less than 500 hr/yr). (Sec/m^3)

$(\overline{X/Q})_m$ = For partially elevated release points. The highest calculated annual average relative concentration for areas at or beyond the site boundary for long-term releases (greater than 500 hr/yr). (Sec/m^3)

$(X/q)_m$ = For partially elevated release points. The relative concentration for areas at or beyond the site boundary for short-term releases (equal to or less than 500 hr/yr). (Sec/m^3)



q_{im} = The average release of noble gas radionuclides in gaseous effluents, i , for short-term releases (equal to or less than 500 hr/yr) from the main plant release point, in μCi . Releases shall be cumulative over the calendar quarter or year, as appropriate.

q_{ig} = The average release of noble gas radionuclides in gaseous effluents, i , for short-term releases (equal to or less than 500 hr/yr) from Radwaste and Turbine Building, in μCi . Releases shall be cumulative over the calendar quarter or year, as appropriate.

Q_{im} = The average release of noble gas radionuclides in gaseous releases, i , for long-term releases (greater than 500 hr/yr) from the main plant release point, in μCi . Release shall be cumulative over the calendar quarter or year, as appropriate.

Q_{ig} = The average release of noble gas radionuclides in gaseous effluents, i , for long-term releases (greater than 500 hr/yr) from Radwaste and Turbine Building, in μCi . Releases shall be cumulative over the calendar quarter or year, as appropriate.

3.17×10^{-8} = The inverse of the number of seconds in a year.

3.4.2 Radioiodines and Particulates (Technical Specification 3.11.2.3)

The following equation calculates the dose to an individual from radioiodines, radioactive material in particulate form, and radionuclides other than noble gases with half-lives greater than eight days in gaseous effluents released to the unrestricted areas:



a. During any calendar quarter:

$$3.17 \times 10^{-8} \sum_i R_i \left[W_m Q_{im} + w_m q_{im} + W_g Q_{ig} + w_g q_{ig} \right] \leq 7.5 \text{ mrem} \quad (12)$$

b. During any calendar year:

$$3.17 \times 10^{-8} \sum_i R_i \left[W_m Q_{im} + w_m q_{im} + W_g Q_{ig} + w_g q_{ig} \right] \leq 15 \text{ mrem} \quad (13)$$

where:

Q_{im}, Q_{ig} = The releases of radionuclides, radioactive materials in particulate form, and radionuclides other than noble gases in gaseous effluents, i , for long-term releases greater than 500 hr/yr, in μCi . Releases shall be cumulative over the calendar quarter or year, as appropriate (m is for mixed mode releases, g is for ground level releases).

q_{im}, q_{ig} = The releases of radionuclides, radioactive materials in particulate form, and radionuclides other than noble gases in gaseous effluents, i , for short-term releases equal to or less than 500 hr/yr, in μCi . Releases shall be cumulative over the calendar quarter or year as appropriate (m is for mixed mode releases, g is for ground level releases).



W_m, W_g = The dispersion parameter for estimating the dose to an individual at the controlling location for long-term (> 500 hr.) releases (m is for mixed mode releases, g is for ground level releases).

$W = (\overline{X/Q})$ for the inhalation pathway, in sec/m^3 .

$W = (\overline{D/Q})$ for the food and ground plane pathways in meters^{-2} .

w_m, w_g = The dispersion parameter for estimating the dose to an individual at the controlling location for short-term (< 500 hr.) releases (m is for mixed mode releases, g is for ground level releases).

$w = (\overline{X/q})$ for the inhalation pathway, in sec/m^3 .

$w = (\overline{D/q})$ for the food and ground plane pathways in meters^{-2} .

3.17×10^{-8} = The inverse of the number of seconds in a year.

R_i = The dose factor for each identified radionuclide, i, in $\text{m}^2(\text{mrem/yr per } \mu\text{Ci/sec})$ or $\text{mrem/yr per } \mu\text{Ci/m}^3$.



3.4.2.1 Dose Parameter for Radionuclide i (R_i)

The R_i values used in equations 12 and 13 of this section are calculated separately for each of the following potential exposure pathways:

- o Inhalation
- o Ground plane contamination
- o Grass-cow/goat-milk pathway
- o Grass-cow-meat pathway
- o Vegetation pathway

Monthly dose assessments for WNP-2 gaseous effluent will be done for all age groups.

Calculation of R_i^I (Inhalation Pathway Factor)

$$R_i^I (\text{Inhalation}) = K^I (BR)_a (DFA_i)_a (\text{mrem/yr per } \mu\text{Ci/m}^3) \quad (14)$$

where:

- R_i^I = The inhalation pathway factor (mrem/yr per $\mu\text{Ci/m}^3$).
- K^I = A constant of unit conversion, 10^6 pCi/ μCi .
- $(BR)_a$ = The breathing rate of the receptor of age group (a) in meter³/yr. (Infant = 1400, child = 3,700, teen = 8,000, adult = 8,000. From P.32 NUREG-0133).



$(DFA_i)_a$ = The maximum organ inhalation dose factor for receptor of age group (a) for the ith radionuclide (mrem/pCi). The total body is considered as an organ in the selection of $(DFA_i)_a$. $(DFA_i)_a$ values are listed in Tables E-7 through E-10 of Regulatory Guide 1.109 manual, Revision 1. Values of R_i^I are listed in Table 3-5.

Calculation of R_i^G (Ground Plane Pathway Factor)

$$R_i^G(\text{Ground Plane}) = K^A K^B (SF)(DFG_i) (1 - e^{-\lambda_i t}) / \lambda_i \quad (\text{m}^2 \times \text{mrem/yr per } \mu\text{Ci/sec}) \quad (15)$$

where:

R_i^G = Ground plane pathway factor ($\text{m}^2 \times \text{mrem/yr per } \mu\text{Ci/sec}$).

K^A = A conversion constant of ($10^6 \text{ pCi}/\mu\text{Ci}$).

K^B = A conversion constant - (8760 hr/yr).

λ_i = The decay constant for the ith radionuclide (sec^{-1}).

t = Exposure time, $4.73 \times 10^8 \text{ sec}$ (15 years).

DFG_i = The ground plane dose conversion factor for the ith radionuclide, as listed in Table E-6 of Regulatory Guide 1.109, Revision 1 ($\text{mrem/hr per pCi/m}^2$).

SF = Shielding Factor (dimensionless)--0.7 if building is present, as suggested in Table E-15 of Regulatory Guide 1.109, Revision 1.



$(DFL_i)_a$ = The maximum organ ingestion dose factor for the i th radionuclide for the receptor in age group (a), in mrem/pCi (Tables E-11 to E-14 of Regulatory Guide 1.109, Revision 1).

λ_i = The decay constant for the i th radionuclide, in sec^{-1} .

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, $5.73 \times 10^{-7} \text{ sec}^{-1}$ (corresponding to a 14-day half-life).

t_f = The transport time from pasture to animal, to milk, to receptor, in sec.

t_h = The transport time from pasture, to harvest, to animal, to milk, to receptor, in sec.

f_p = Fraction of the year that the cow/goat is on pasture (dimensionless).

f_s = Fraction of the cow/goat feed that is pasture grass while the cow is on pasture (dimensionless).

The input parameters used for calculating R_i^C are listed in Table 3-6 and the R_i^M values are tabulated in Table 3-7.

For Tritium:

In calculating R_T^C , pertaining to tritium in milk, the airborne concentration rather than the deposition will be used:

R_T^C (Grass-Cow/Goat-Milk Factor) =

$$K^A K^C F_m Q F_{ap} (DFL_i)_a \left[0.75(0.5/H) \right] \text{ (mrem/yr per } \mu\text{Ci/m}^3\text{)} \quad (17)$$



t_f = The transport time from pasture to receptor, in sec.

t_h = The transport time from crop field to receptor, in sec.

The input parameters needed for solving equation 18 are listed in Table 3-7.

For Tritium:

In calculating the R_T^M for tritium in meat, the airborne concentration is used rather than the deposition rate. The following equation is used to calculate the R_T^M values for tritium:

R_T^M (Grass-Cow-Meat Pathway) =

$$K^A K^C \left[F_f Q_F U_{ap} (DFL_i)_a \right] \left[0.75(0.5/H) \right] \text{ (mrem/yr per } \mu\text{Ci/m}^3 \text{)} \quad (19)$$

Where the terms are as defined in equations 16-18, R_i^M values for tritium pertaining to the infant age group is zero since there is no meat consumption by this age group.

Calculation of R_i^V (Vegetation Pathway Factor)

R_i^V (Vegetation Pathway Factor) =

$$K' \left[\frac{(r)}{Y_V(\lambda_i + \lambda_W)} (DFL_i)_a \right] \left[U_{afL}^L e^{-\lambda_i t_L} + U_{afg}^S e^{-\lambda_i t_h} \right] \quad (20)$$

($m^2 \times \text{mrem/yr per } \mu\text{Ci/sec}$)

R_T^V (Vegetation Pathway Factor) =

$$K^A K^C \left[(U_{afL}^L + U_{afg}^S) (DFL_i)_a \right] \left[0.75(0.5/H) \right] \text{ (mrem/yr per } \mu\text{Ci/m}^3 \text{)} \quad (21)$$

Where all terms have been defined above and in equations 15-18, the R_i^V value for tritium is zero for the infant age group due to zero vegetation consumption rate by that age group. The input parameters needed for solving equations 20 and 21 are listed in Table 3-8.

3.4.3 Annual Doses At Special Locations

The Radioactive Effluent Release Report submitted within 60 days after January 1 of each year shall include an assessment of the radiation doses from radioactive gaseous effluents to, "Members of the Public", due to their activities inside the site boundary during the report period.

Annual doses within the site boundary have been determined for several locations using the NRC GASPAR computer code and source term data from Table 11.3-7 of the FSAR. These values are listed in Tables 3-16 and 3-17. Of the locations listed within the site boundary, only two, the DOE Train and WNP-2 Visitor Center are considered as being occupied by a "Member of the Public". Annual doses to the maximum exposed "Member of the Public" shall be determined for an individual at the WNP-2 Visitor Center based on occupancy of 8 hours per year due to it being the higher of the two locations.

3.5 Compliance with Standard Technical Specification 3.11.2.4

Standard Technical Specification 3.11.2.4 states:

"The GASEOUS RADWASTE TREATMENT SYSTEM shall be in operation in either the normal or charcoal bypass mode. The charcoal bypass mode shall not be used unless the offgas post-treatment radiation monitor is OPERABLE as specified in Table 3.3.7.11-1."

"APPLICABILITY: Whenever the main condenser steam jet air ejector (evacuation) system is in operation."



Prior to placing the Gaseous Radwaste Treatment System in the charcoal bypass mode, the alarm setpoints on the main plant vent release monitor shall be set to account for the increased percentages of short-lived noble gases. Noble gas percentages shall be based either on actual measured values or on primary coolant design base noble gas concentration percentages adjusted for 30-minute decay. Table 3-15 lists the percentage values for 30-minute decay.

3.6 Calculation of Gaseous Effluent Monitor Alarm Setpoints

3.6.1 Introduction

The following procedure used to ensure that the dose rate in the unrestricted areas due to noble gases in the WNP-2 gaseous effluent do not exceed 500

mrem/yr to the whole body or 3000 mrem/yr to the skin. The initial setpoints determination is calculated using a conservative radionuclide mix obtained from the WNP-2 GALE code. Once the plant is operating and sufficient measurable process fission gases are in the effluent, then the actual radionuclide mix will be used to calculate the alarm setpoint.

3.6.2 Setpoint Determination for all Gaseous Release Paths

The setpoints for gaseous effluent are based on an instantaneous noble gas dose rates. A monthly analysis of radioiodines and radionuclides in particulate form will be performed to ensure compliance with 10 CFR 20 and 10 CFR 50 Appendix I limits. The three release points will be partitioned such that their sum does not exceed 100 percent of the limit. Originally, the setpoints will be set at 40 percent for the reactor building, 40 percent for the turbine building and 20 percent for the radwaste building. These percentages could vary at the plant discretion, should the operational conditions warrant such change. However, the combined releases due to variations in the setpoints will not result in doses which exceed the limit stated in technical specification. Both skin dose and whole body setpoints will be calculated and the lower limit will be used.

3.6.2.1 Setpoints Calculations Based on Whole Body Dose Limits

The fraction (π_i) of the total gaseous radioactivity in each gaseous effluent release path (j) for each noble gas radionuclide i will be determined by using the following equation:

$$\pi_{ij} = \frac{C_{ij}}{C_{Tj}} \quad (\text{dimensionless}) \quad (22)$$

where:

C_{ij} = The measured individual concentration of radionuclide i in the gaseous effluent release path j ($\mu\text{Ci/cc}$).



C_{Tj} = The measured total concentration of all noble gases identified in the gaseous effluent release path j ($\mu\text{Ci/cc}$).

Based on Technical Specification 3.11.2.1, the maximum acceptable release rate of all noble gases in the gaseous effluent release path j is calculated by using the following equation:

$$Q_{Tj} = \frac{Fj \ 500}{X/Q_j \sum_{i=1}^m (K_i)(\pi_{ij})} \quad (\mu\text{Ci/sec}) \quad (23)$$

where:

Q_{Tj} = The maximum acceptable release rate ($\mu\text{Ci/sec}$) of all noble gases in the gaseous effluent release path j ($\mu\text{Ci/cc}$).

Fj = Fraction of total dose allocated to release path j.

500 = Whole body dose rate limit of 500 mrem/yr as specified in Technical Specification 3.11.2.1a.

X/Q_j = Maximum normalized diffusion coefficient of effluent release path j at the site boundary (sec/m^3). Turbine Building and Radwaste Building values are based on average annual ground level values. Main plant vent release values are for mixed mode and may be either short term or average annual value dependent upon type of release.

K_i = The total whole body dose factor due to gamma emission from noble gas nuclide i (mrem/yr per $\mu\text{Ci/m}^3$) (as listed in Table B-1 of Regulatory Guide 1.109, Revision 1).



π_{ij} = As defined in equation 22.

m = Total number of radionuclides in the gaseous effluent.

j = Different release pathways.

The total maximum acceptable concentration (C_{Tj}) of noble gas radionuclides in the gaseous effluent release path j ($\mu\text{Ci/cc}$) will be calculated by using the following equation:

$$C_{Tj} = \frac{Q_{Tj}}{R_j} (\mu\text{Ci/cc}) \quad (24)$$

where:

C_{Tj} = The total allowed concentration of all noble gas radionuclides in the gaseous effluent release path j ($\mu\text{Ci/cc}$).

Q_{Tj} = The maximum acceptable release rate ($\mu\text{Ci/sec}$) of all noble gases in the gaseous effluent release path j .

R_j = The effluent release rate (cc/sec) at the point of release.

To determine the maximum acceptable concentration (C_{ij}) of noble gas radionuclide i in the gaseous effluent for each individual noble gas in the gaseous effluent ($\mu\text{Ci/cc}$), the following equation will be used:

$$C_{ij} = \pi_{ij} C_{Tj} (\mu\text{Ci/cc}) \quad (25)$$



where:

- Q_{Tj} = The maximum acceptable release rate of all noble gases in the gaseous effluent release path j in $\mu\text{Ci/sec}$.
- X/Qj = The maximum annual normalized diffusion coefficient for release path j at the site boundary (sec/m^3).
- F_j = Fraction of total allowed dose.
- L_i = The skin dose factor due to beta emission for each identified noble gas radionuclide i in $\text{mrem/yr per } \mu\text{Ci/m}^3$ (L_i values are listed in Table 3-1).
- M_i = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in $\text{mrad/yr per } \mu\text{Ci/m}^3$ (M_i values are listed in Table 3-1).
- 1.1 = A conversion factor to convert dose in mrad to dose equivalent in mrem.
- 3000 = Skin dose rate limit of 3000 mrem/yr as specified in Technical Specification 3.11.2.1.



Table 3-1
DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i	Skin Dose Factor L_i	Gamma Air Dose Factor M_i	Beta Air Dose Factor N_i
	(mrem/yr per $\mu\text{Ci}/\text{m}^3$)	(mrem/yr per $\mu\text{Ci}/\text{m}^3$)	(mrad/yr per $\mu\text{Ci}/\text{m}^3$)	(mrad/yr per $\mu\text{Ci}/\text{m}^3$)
Kr-85m	1.17E+03**	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.

**7.56E-02 = 7.56×10^{-2} .

The values listed above were taken from Table B-1 of NRC Regulatory Guide 1.109, Revision 1. The values were multiplied by 10^6 to convert picocuries⁻¹ to microcuries⁻¹.



Table 3-4

DOSE RATE PARAMETERS
IMPLEMENTATION OF 10 CFR 20, AIRBORNE RELEASES

Nuclide	$\text{sec}^{\lambda-1}$	Child Dose Factor*		P_i^I Inhalation $\frac{\text{mrem/yr}}{\mu\text{Ci/m}^3}$
		DFA_i $\frac{\text{mrem/pCi}}{\text{pCi/m}^2}$	DFG_i $\frac{\text{mrem/hr}}{\text{pCi/m}^2}$	
H-3	1.8E-09	3.0E-07	0.0	1.1E+03
I-131	1.0E-06	4.4E-03	3.4E-09	1.6E+07
I-133	9.2E-06	1.0E-03	4.5E-09	3.7E+06
Cr-51	2.9E-07	4.6E-06	2.6E-10	1.7E+04
Mn-54	2.6E-08	4.3E-04	6.8E-09	1.6E+06
Fe-55	8.5E-09	3.0E-05	0.0	1.1E+05
Fe-59	1.8E-07	3.4E-04	9.4E-09	1.3E+06
Co-58	1.1E-07	3.0E-04	8.2E-09	1.1E+06
Co-60	4.2E-09	1.9E-03	2.0E-08	7.0E+06
Zn-65	3.3E-08	2.7E-04	4.6E-09	1.0E+06
Sr-89	1.5E-07	5.8E-04	6.5E-13	2.2E+06
Sr-90	7.9E-10	2.7E-02	2.6E-12**	1.0E+08
Zr-95	1.2E-07	6.3E-04	5.8E-09	2.3E+06
Mo-99	2.9E-06	3.7E-05	2.2E-09	1.4E+05
Cs-134	1.1E-08	2.7E-04	1.4E-08	1.0E+06
Cs-137	7.3E-010	2.5E-04	4.9E-09	9.3E+05
Ba-140	6.3E-07	4.7E-04	2.4E-09	1.7E+06
Ce-141	2.4E-07	1.5E-04	6.2E-10	5.4E+05
Ce-144	2.8E-08	3.2E-03	2.5E-09	1.2E+07

* Maximum Organ

**No data is listed for Sr-90 in Table E-6 of Regulatory Guide 1.109, Revision 1. Y-90 values were used for dose conversion factor Sr-90.



1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial system and for providing a clear audit trail.



2. The second part of the document outlines the specific procedures for recording transactions. It details the steps involved in entering data into the system, from initial data collection to final verification. It also discusses the importance of regular backups and the use of secure communication channels.



Table 3-5a

DOSE RATE PARAMETERS--IMPLEMENTATION OF 10 CFR 50, AIRBORNE RELEASES

Age Group: Infant

Nuclide	sec ⁻¹	Dose Parameters (Maximum Organ)			
		Inhalation	Ground	Milk (Cow)	Milk (Goat)
		R _I ^I	R _I ^G	R _I ^C	R _I ^C
		mrem/yr ($\mu\text{Ci}/\text{m}^3$)	m ² x mrem/yr ($\mu\text{Ci}/\text{sec}$)	m ² x mrem/yr ($\mu\text{Ci}/\text{sec}$)	m ² x mrem/yr ($\mu\text{Ci}/\text{sec}$)
H-3	1.8E-9	6.5E+2	0.0	3.4E+3	7.0E+3
I-131	1.0E-6	1.5E+7	1.0E+7	2.4E+11	4.3E+11
I-133	9.2E-6	3.6E+6	1.5E+6	2.2E+9	4.0E+9
Cr-51	2.9E-7	1.3E+4	5.5E+6	2.0E+6	3.5E+5
Fe-55	8.5E-9	8.7E+4	0.0	7.0E+7	7.1E+6
Fe-59	1.8E-7	1.0E+6	3.2E+8	1.7E+8	3.2E+7
Mn-54	2.6E-8	9.9E+5	1.6E+9	2.0E+7	2.9E+6
Co-58	1.1E-7	7.8E+5	4.4E+8	2.8E+7	4.5E+6
Co-60	4.2E-9	4.5E+6	2.5E+10	1.1E+8	1.4E+7
Sr-89	1.5E-7	2.0E+6	2.5E+4	5.6E+9	1.6E+10
Sr-90	7.9E-10	4.1E+7	8.9E+6*	7.1E+10	1.7E+11
Mo-99	2.9E-6	1.3E+5	4.7E+6	1.6E+8	2.4E+8
Cs-134	1.1E-8	7.0E+5	8.0E+9	3.6E+10	1.3E+11
Cs-136	5.9E-7	5.6E+4	1.7E+8	2.6E+9	1.2E+10
Cs-137	7.3E-10	6.1E+5	1.2E+10	3.4E+10	1.2E+11
Ba-140	6.3E-7	1.6E+6	2.3E+7	1.1E+8	1.9E+7
Ce-141	2.4E-7	5.2E+5	1.5E+7	3.6E+7	6.2E+6
Ce-144	2.8E-8	9.8E+6	8.0E+7	1.1E+8	6.0E+7

*No data is listed for Sr-90 in Table E-6 of Regulatory Guide 1.109, Revision 1.
Y-90 values were used for the dose conversion factor for Sr-90.



Table 3-5b

DOSE RATE PARAMETERS--IMPLEMENTATION OF 10 CFR 50, AIRBORNE RELEASES

Age Group: Child

Nuclide	sec ⁻¹	Dose Parameters (Maximum Organ)					
		Inhalation	Ground	Milk (Cow)	Milk (Goat)	Vegetables	Meat
		R_I^I	R_I^G	R_I^C	R_I^C	R_I^V	R_I^H
		mrem/yr ($\mu\text{Ci}/\text{m}^3$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)
H-3	1.0E-9	1.1E+3	0.0	2.3E+3	4.6E+3	5.6E+3	3.4E+2
I-131	1.0E-6	1.6E+7	1.0E+7	9.9E+10	1.8E+11	1.1E+10	1.3E+9
I-133	9.2E-6	3.8E+6	1.5E+6	9.2E+8	1.7E+9	1.7E+8	3.0E+1
Cr-51	2.9E-7	1.7E+4	5.5E+6	2.3E+6	4.1E+5	5.3E+6	2.0E+5
Fe-55	0.5E-9	1.1E+5	0.0	5.8E+7	9.1E+6	3.9E+8	2.4E+8
Fe-59	1.0E-7	1.3E+6	3.2E+8	9.0E+7	1.6E+7	6.0E+8	2.8E+8
Mn-54	2.6E-8	1.6E+6	1.6E+9	1.1E+7	1.6E+6	6.3E+8	4.1E+6
Co-58	1.1E-7	1.1E+6	4.4E+8	3.2E+7	5.2E+6	3.4E+8	4.4E+7
Co-60	4.2E-9	7.1E+6	2.5E+10	1.3E+8	1.8E+7	2.0E+9	2.1E+8
Sr-89	1.5E-7	2.2E+6	2.5E+4	3.0E+9	8.6E+9	3.3E+10	2.2E+8
Sr-90	7.9E-10	1.0E+8	8.9E+6*	6.5E+10	1.6E+11	1.3E+12	6.1E+9
Hb-99	2.9E-6	1.4E+5	4.7E+6	8.8E+7	1.3E+8	7.0E+6	1.3E+5
Cs-134	1.1E-8	1.0E+6	8.0E+9	2.0E+10	7.0E+10	2.5E+10	7.9E+8
Cs-136	5.9E-7	1.7E+5	1.7E+8	1.2E+9	5.6E+9	1.5E+8	2.0E+7
Cs-137	7.3E-10	9.1E+5	1.2E+10	1.8E+10	6.4E+10	2.4E+10	7.5E+8
Ba-140	6.3E-7	1.7E+6	2.3E+7	5.2E+7	9.4E+6	1.8E+8	2.0E+7
Ce-141	2.4E-7	5.4E+5	1.6E+7	3.6E+7	6.2E+6	3.6E+8	6.0E+6
Ce-144	2.8E-8	1.2E+7	8.0E+7	4.0E+8	5.9E+7	9.5E+9	9.5E+7

*No data is listed for Sr-90 in Table E-6 of Regulatory Guide 1.109, Revision 1.
Y-90 values were used for the dose conversion factor for Sr-90.



Table 3-5c

DOSE RATE PARAMETERS--IMPLEMENTATION OF 10 CFR 50, AIRBORNE RELEASES

Age Group: Teen

Nuclide	sec^{-1}	Dose Parameters (Maximum Organ)					
		Inhalation	Ground	Milk (Cow)	Milk (Goat)	Vegetables	Meat
		R_i^I	R_i^G	R_i^C	R_i^C	R_i^V	R_i^M
		mrem/yr ($\mu\text{Ci}/\text{m}^3$)	$\text{m}^2 \times \text{mrem/yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem/yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem/yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem/yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem/yr}$ ($\mu\text{Ci}/\text{sec}$)
H-3	1.8E-9	1.3E+3	0.0	1.4E+3	2.9E+3	3.5E+3	2.8E+2
I-131	1.0E-6	1.5E+7	1.0E+7	5.1E+10	9.1E+10	7.0E+9	8.4E+8
I-133	9.2E-6	2.9E+6	1.5E+6	3.9E+8	7.0E+8	9.4E+7	1.7E+1
Cr-51	2.9E-7	2.1E+4	5.5E+6	3.6E+6	6.4E+5	8.5E+6	4.1E+5
Fe-55	8.5E-9	1.2E+5	0.0	1.6E+7	3.6E+6	3.0E+8	8.8E+7
Fe-59	1.8E-7	1.5E+6	3.2E+8	1.3E+8	2.3E+7	8.7E+8	5.2E+8
Hn-54	2.6E-8	2.0E+6	1.6E+9	1.5E+7	2.2E+6	3.7E+8	7.4E+6
Co-58	1.1E-7	1.3E+6	4.4E+8	5.0E+7	8.1E+6	5.4E+8	8.9E+7
Co-60	4.2E-9	8.7E+6	2.5E+10	2.0E+8	2.8E+7	3.1E+9	4.1E+8
Sr-89	1.5E-7	2.4E+6	2.5E+4	1.2E+9	3.5E+9	1.3E+10	1.1E+8
Sr-90	7.9E-10	1.1E+8	8.9E+6*	3.8E+10	9.4E+10	7.9E+11	4.7E+9
Mo-99	2.9E-6	2.7E+5	4.7E+6	5.2E+7	7.8E+7	5.5E+6	1.0E+5
Cs-134	1.1E-8	5.5E+5	8.0E+9	1.2E+10	4.4E+10	1.5E+10	6.5E+8
Cs-136	5.9E-7	1.9E+5	1.7E+8	7.9E+8	3.5E+9	1.0E+10	1.6E+7
Cs-137	7.3E-10	8.5E+5	1.2E+10	1.0E+10	3.5E+10	1.3E+10	5.4E+8
Ba-140	6.3E-7	2.0E+6	2.3E+7	3.3E+7	6.0E+6	1.2E+8	1.6E+7
Ce-141	2.4E-7	6.1E+5	1.6E+7	4.4E+7	7.7E+6	4.6E+8	9.8E+6
Ce-144	2.8E-8	1.3E+7	8.0E+7	5.0E+8	7.4E+7	1.2E+10	1.6E+8

*No data is listed for Sr-90 in Table E-6 of Regulatory Guide 1.109, Rev. 1.
Y-90 values were used for the dose conversion factor for Sr-90.

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Table 3-5d

DOSE RATE PARAMETERS--IMPLEMENTATION OF 10 CFR 50, AIRBORNE RELEASES

Age Group: Adult

Nuclide	λ^{-1} sec	Dose Parameters (Maximum Organ)					
		Inhalation	Ground	Milk (Cow)	Milk (Goat)	Vegetables	Meat
		R_I^I	R_I^G	R_I^C	R_I^C	R_I^V	R_I^H
		mrem/yr ($\mu\text{Ci}/\text{m}^3$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)	$\text{m}^2 \times \text{mrem}/\text{yr}$ ($\mu\text{Ci}/\text{sec}$)
H-3	1.8E-9	1.3E+3	0.0	1.1E+3	2.2E+3	3.0E+3	4.7E+2
I-131	1.0E-6	1.2E+7	1.0E+7	3.2E+10	5.7E+10	8.2E+9	1.2E+9
I-133	9.2E-6	2.2E+6	1.5E+6	2.3E+8	4.1E+8	1.1E+8	2.2E+1
Cr-51	2.9E-7	1.4E+4	5.5E+6	3.1E+6	5.5E+5	8.7E+6	7.7E+5
Fe-55	8.5E-9	7.2E+4	0.0	1.3E+7	2.0E+6	1.8E+8	1.5E+8
Fe-59	1.8E-7	1.0E+6	3.2E+8	1.0E+8	1.9E+7	8.0E+8	9.2E+8
Mn-54	2.6E-8	1.4E+6	1.6E+9	1.3E+7	1.9E+6	8.5E+8	1.4E+7
Co-58	1.1E-7	9.3E+5	4.4E+8	4.4E+7	7.1E+6	5.3E+8	1.7E+8
Co-60	4.2E-9	6.0E+6	2.5E+10	1.7E+8	2.4E+7	2.9E+9	7.6E+8
Sr-89	1.5E-7	1.4E+6	2.5E+4	6.5E+8	1.9E+9	8.2E+9	1.3E+8
Sr-90	7.9E-10	9.9E+7	8.9E+6*	2.7E+10	6.7E+10	6.2E+11	7.2E+9
Mo-99	2.9E-6	2.5E+5	4.7E+6	2.9E+7	4.4E+7	6.0E+6	1.2E+5
Cs-134	1.1E-8	8.5E+5	8.0E+9	7.0E+9	2.5E+10	9.9E+9	8.2E+8
Cs-136	5.9E-7	1.5E+5	1.7E+8	4.6E+8	2.1E+9	9.0E+7	2.1E+7
Cs-137	7.3E-10	6.2E+5	1.2E+10	5.6E+9	1.5E+10	8.3E+9	6.7E+8
Ba-140	6.3E-7	1.3E+6	2.3E+7	2.5E+7	4.4E+6	1.4E+8	2.6E+7
Ce-141	2.4E-7	3.6E+5	1.5E+7	3.3E+7	5.7E+6	4.0E+8	1.6E+7
Ce-144	2.8E-8	8.6E+7	8.0E+7	3.7E+8	5.4E+7	1.0E+10	2.5E+8

*No data is listed for Sr-90 in Table E-6 of Regulatory Guide 1.109, Revision 1.
Y-90 values were used for the dose conversion factor for Sr-90.



Table 3-6

INPUT PARAMETERS FOR CALCULATING R_i^C

Parameter	Value	Table*
r (dimensionless)	1.0 for radioiodine 0.2 for particulates	E-15 E-15
F_m (days/liter)	Each stable element	E-1
U_{ap} (liters/yr)--Infant	330	E-5
--Child	330	E-5
--Teen	400	E-5
--Adult	310	E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
Y_p (kg/m ²)	0.7	E-15
Y_s (kg/m ²)	2.0	E-15
t_f (seconds)	1.73×10^5 (2 days)	E-15
t_h (seconds)	7.78×10^6 (90 days)	E-15
Q_F (kg/day)	50 for cow 6 for goat	E-3 E-3
f_s (dimensionless)	1.0	NUREG-0133
f_p (dimensionless)	0.5 for cow 0.75 for goat	Site specific Site specific

*Of Regulatory Guide 1.109, Revision 1 unless stated otherwise.



Table 3-7

INPUT PARAMETERS FOR CALCULATING R_i^M

Parameter	Value	Table*
r (dimensionless)	1.0 for radioiodine 0.2 for particulates	E-15 E-15
F_f (days/kg)	Each stable element	E-1
U_{ap} (kg/yr)--Infant	0	E-5
--Child	41	E-5
--Teen	65	E-5
--Adult	110	E-5
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
γ_p (kg/m ²)	0.7	E-15
γ_s (kg/m ²)	2.0	E-15
t_f (seconds)	1.73×10^6 (20 days)	E-15
t_h (seconds)	7.78×10^6 (90 days)	E-15
Q_F (kg/day)	50	E-3

*Of Regulatory Guide 1.109, Revision 1.



Table 3-8

INPUT PARAMETERS FOR CALCULATING R_i^V

Parameter	Value	Table*
r (dimensionless)	1.0 for radioiodine 0.2 for particulates	E-1 E-1
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
U_a^L (kg/yr)--Infant	0	E-5
--Child	26	E-5
--Teen	42	E-5
--Adult	64	E-5
U_a^S (kg/yr)--Infant	0	E-5
--Child	520	E-5
--Teen	630	E-5
--Adult	520	E-5
f_L (dimensionless)	Site specific (default = 1.0)	E-5
f_g (dimensionless)	Site specific (default = 0.76)	RG 1.109, p 28
t_L (seconds)	8.6×10^4 (1 day)	E-15
t_h (seconds)	5.18×10^6 (60 days)	E-15
Y_v (kg/m ²)	2.0	E-15

*Of Regulatory Guide 1.109, Revision 1.

Table 3-9

INPUT PARAMETERS NEEDED FOR CALCULATING DOSE
TO THE MAXIMUM INDIVIDUAL FROM WNP-2 GASEOUS EFFLUENT

<u>Input Parameter</u>	<u>Value</u>	<u>Reference*</u>
Distance to Maine (miles)	3000	Ref 1
Fraction of year leafy vegetables are grown	0.42	Ref 2
Fraction of year cows are on pasture	0.5	Ref 2
Fraction of crop from garden	0.76	Ref 3
Fraction of daily intake of cows derived from pasture while on pasture	1.0	Ref 3
Annual average relative humidity (%)	53.8	Ref 4
Annual average temperature (F°)	53.0	Ref 5
Fraction of year goats are on pasture	0.75	Ref 2
Fraction of daily intake of goats derived from pasture while on pasture	1.0	Ref 2
Fraction of year beef cattle are on pasture	0.5	Ref 2
Fraction of daily intake of beef cattle derived from pasture while on pasture	1.0	Ref 2
Population within 50 miles of plant and the year that the population is used	336,115 (year 2000)	Ref 6
Annual 50-mile milk production (liters/yr)	9.91E+06	Refs 7 & 9
Annual 50-mile meat production (kg/yr)	3.54E+06	Refs 6, 7, & 9
Annual 50-mile vegetable production (kg/yr)	2.0E+07	Refs 6, 7, & 9
Source terms		Ref 8

Table 3-9 (contd.)

Input Parameter	Value	Reference
X/Q values by sector for each distance (recirculation, no decay) (sec/m ³)	See Tables 3-11 through 3-12	Ref 10
X/Q values by sector for each distance (recirculation, 2.26 days decay, undepleted) (sec/m ³)	See Tables 3-11 through 3-12	Ref 10
X/Q values by sector for each distance (recirculation, 8.0 days decay, depleted) (sec/m ³)	See Table 3-11 through 3-12	Ref 10
D/Q values by sector for each distance (l/m ²)	See Table 3-11 through 3-12	Ref 10

*References are listed in Table 3-14.

Table 3-14

REFERENCES FOR VALUES LISTED IN TABLE 3-9

Reference 1	U.S. Map
Reference 2	Site Specific
Reference 3	Regulatory Guide 1.109, Revision 1, Table E-15
Reference 4	Section 2.3, WNP-2 FSAR, Table 2.3-20
Reference 5	Section 2.3, WNP-2 FSAR, page 2.3-3
Reference 6	Keith E. Yandon, October 1980, "Projections and Distributions of Population Within a 50-Mile Radius of Washington Public Power Supply System Nuclear Projects Nos. 1, 2, and 4 by Compass Direction and Radii Intervals," 1970-2030
Reference 7	WNP-2 ER, Table 5.2-12
Reference 8	WNP-2 Effluent Analysis for Applicable Time Period
Reference 9	Radiological Programs Calculation Log No. 83-1
Reference 10	WNP-2 XOQDOO Computer Run

TABLE 3-16 ANNUAL DOSES AT SPECIAL LOCATIONS WITHIN WNP-2 SITE BOUNDARY

Source: WNP-2 Gaseous Effluent

Location	Distance (Miles)	Occupancy (hrs/yr)	Whole Body Dose (mrem/yr)	Thyroid Dose (mrem/yr)
BPA Ashe Substation	0.5 N	2080	1.1E+00	1.7E+00
DOE Train	0.5 SE*	78	6.7E-02	1.0E-01
Wye Burial Site	0.5 WMW	8	4.1E-03	6.5E-03
WNP-1	1.2 ESE	2080	3.8E-02	1.3E-01
WNP-4	1.0 ENE	2080	7.0E-02	1.1E-01
WNP-2 Visitor Center	0.08 ESE	8	8.6E-02	1.3E-01
Taylor Flats**	4.2 SE	8760	3.1E-02	5.2E+00
Site Boundary***	1.2 SE	8760	1.1E+00	1.7E+00

*The sector with the highest X/Q values (within 0-0.5 mile radius) was used.

**Not within site boundary. Closest residential area representative of maximum individual dose from plume, ground, ingestion, and inhalation exposure pathways. Included for comparison.

***Assumed continuously occupied. Actual occupancy is very low. Doses from Inhalation and Ground Exposure pathways. No food crops.



TABLE 3-17 ANNUAL OCCUPIED AIR DOSE AT SPECIAL LOCATIONS
WITHIN WNP-2 SITE BOUNDARY

<u>Location</u>	<u>Annual Beta Air dose (mrad)</u>	<u>Annual Gamma Air Dose (mrad)</u>
BPA Ashe Substation	8.9E-01	1.5E+00
DOE Train	5.3E-02	9.2E-02
Wye Burial Site	3.2E-03	5.7E-03
WNP-1	3.3E-02	2.8E-02
WNP-4	5.3E-02	8.5E-02
WNP-2 Visitor Center	7.0E-02	1.2E-01
Taylor Flats*	2.3E-02	1.4E-02
Site Boundary	8.7E-01	1.5E+00

*Not within site boundary. Closest residential area. Included for comparison.



4.0 COMPLIANCE WITH 40 CFR 190

4.1 Technical Specification Requirement

Technical Specification 3.11.4 states, "The annual (calendar year) dose or dose commitment to any Member of the Public, due to release of radioactivity and radiation, from uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem.

4.2 ODCM Methodology for Determining Dose and Dose Commitment from Uranium Fuel Cycle Sources

The annual dose or dose commitment to a Member of the Public for the uranium fuel cycle sources is determined as:

- a) Dose to the total body due to the release of radioactive materials in liquid effluents.
- b) Dose to any organ due to the release of radioactive materials in liquid effluents.
- c) Air doses due to noble gases released in gaseous effluents.
- d) Dose to any organ due to the release of radioiodines, tritium and radio-nuclides in particulate form with half-lives greater than 8 days in gaseous effluents.
- e) Dose due to direct radiation from the plant.

The annual dose or dose commitment to a Member of the Public from the uranium fuel cycle sources is determined whenever the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceed twice the limits in Technical Specification 3.11.1.2a, 3.11.1.2b, 3.11.2.2a, 3.11.2.2b, 3.11.2.3a, or 3.11.2.3b. Direct radiation measurements will also be made to determine if the limits of Specification 3.11.4 have been exceeded.

4.2.1 Total Dose from Liquid Effluents

The annual dose to a Member of the Public from liquid effluents will be determined using NRC LADTAP computer code, and methodology presented by equation (5) in Section 2.4. It is assumed that dose contribution pathways to a Member of the Public do not exist for areas within the site boundary.

4.2.2 Total Dose from Gaseous Effluents

The annual dose to a Member of the Public from gaseous effluents will be determined using NRC GASPAR computer code, and methodology presented by equations (10), (11) and (13) in Section 3.4. Appropriate atmospheric dispersion parameters will be used.

4.2.3 Direct Radiation Contribution

The dose to a Member of the Public due to direct radiation from the reactor plant will be determined using thermoluminescent dosimeters (TLDs). TLDs are placed at sample locations and analyzed as per Table 5-1.

TLD stations 1S-16S are special interest stations and will not be used for direct radiation dose determinations to a Member of the Public.

Radiological environmental monitoring activities implemented by PPM 1.11.1 "Radiological Environmental Monitoring Program (REMP) Implementation Procedure", as detailed in the following sections, meet or exceed the criteria of the REMP plan as specified by Plant Technical Specifications, 3/4.12.

5.1 Radiological Environmental Monitoring Program (REMP)

Environmental samples for the REMP are collected in accordance with Table 5-1. This table provides a detailed outline of the environmental sampling plan including both Technical Specification and non Technical Specification items by sample type, sample location code, sampling and collection frequency, and type and frequency of analysis of samples collected within exposure pathway. Deviations from the sampling frequency detailed in Table 5-1 may occur due to circumstances such as hazardous conditions, malfunction of automatic sampling equipment, seasonal unavailability, or other legitimate reasons. When sample media is unobtainable due to equipment malfunction, special actions per program instruction shall be taken to ensure that corrective action is implemented prior to the end of the next sampling period. In some cases, alternate sample collection may be substituted for the missing specimen. All deviations from the sampling plan Technical Specification items detailed in Table 5-1 shall be documented and reported in the Annual Radiological Environmental Operating Report in accordance with PPM 1.10.2, "Routine or Periodic Reports Required by Regulatory Agencies", Regulatory Guide 4.8 and BTP.

In the event that it becomes impossible or impractical to continue sampling a media of choice at currently established location(s) or time, an evaluation shall be made to determine a suitable alternative media and/or location to provide appropriate exposure pathway evaluations. The evaluation and any substitution made shall be implemented in the sampling program within 30 days of identification of the problem. All changes implemented in the sampling program due to unavailability of samples shall be fully documented in the next Semiannual Radioactive Effluent Release Report and ODCM per PPM 1.10.1, "Reportable Events and Occurrences Required by Regulatory Agencies". Revised sampling plan table(s) and figure(s) reflecting the new locations and/or media shall be included with the documentation.



WNP-2 sampling stations are described in Table 5-2. Each station is identified by an assigned number or alphanumeric designation, meteorological sector (16 different, 22-1/2° compass sections) in which the station is located, and radial distance from WNP-2 containment as estimated from map positions. Also included in Table 5-2 is information identifying the type(s) of samples collected at each station and whether or not the specific sample type satisfies a Technical Specification criteria. Figures 5-1 and 5-2 depict the geographical locations of each of the sample stations listed in Table 5-2.

5.2 Land Use Census

A land use census shall be conducted in accordance with the requirements of Plant Technical Specifications. Field activities pertaining to the land use census (LUC) will be initiated during the growing season and completed no later than September 30 each year. The information obtained during the field survey is used along with other demographic data to assess population changes in the unrestricted area that might require modifications in the sampling plan to ensure adequate evaluation of dose commitment. More specific data within each of the 16 meteorological sectors, such as distance to nearest resident, nearest milk animal, and nearest garden greater than 50m² (500 ft²) in size producing broad leaf vegetation shall be identified to support recalculation of maximum individual dose estimates. Site-specific considerations such as the Department of Energy's Hanford Reservation Site Boundary, within which WNP-2 is located, may require that specific information be collected beyond a 5-mile (8 km) radius in certain meteorological sectors to adequately identify pertinent data.

The results of the land use census will be submitted no later than October 31 of each year for evaluation of individual and population doses. All changes, such as a location yielding a greater estimated dose or different location with a 20 percent greater estimated dose than a currently sampled location,



will be reported in the next Semiannual Radiological Effluent Report in accordance with PPM 1.10.2 and Technical Specification. The REMP plan, ODCM, will be changed to reflect new sampling locations.

The best available census information, whether obtained by aerial survey, door-to-door survey, or consultation with local authorities, shall be used to complete the Land Use Survey and the results reported in the Annual Radiological Environmental Operating Report in accordance with PPM 1.10.2 and Technical Specification requirements.

5.3 Laboratory Intercomparison Program

Analysis of REMP samples is contracted to a provider of radiological analytical services. By contract, this analytical service vendor is required to conduct all activities in accordance with Regulatory Guides 4.1, 4.8, and 4.15 and to include in each monthly report; actions pertinent to their participation in the Environmental Protection Agency's (EPA) Environmental Radioactivity Laboratory Intercomparison Studies (Crosscheck) Program. A precontract award survey and annual audit at the contractor's facility ensure that the contractor is participating in the Crosscheck Program, as reported.

The results of the contractor's analysis of Crosscheck samples shall be included in the Annual Radiological Environmental Operating Report in accordance with PPM 1.10.2 and Technical Specification.

Besides the vendor's required participation in the EPA's Crosscheck Program, the Department of Social and Health Services (DSHS) of the State of Washington oversees an analytical program for the Energy Facility Site Evaluation Council (EFSEC) to provide an independent test of WNP-2 REMP sample analyses. The WNP-2/DSHS split samples are analyzed by Washington State's Office of Public Health Laboratories and Epidemiology, Environmental Radiation Laboratory (ERL). The State's ERL participates in the EPA Crosscheck Program, as well as



TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

	<u>Sample Type¹¹</u>	<u>Sample Location Code¹</u>	<u>Sampling and Collection Frequency¹</u>	<u>Type and Frequency of Analysis¹</u>
1.	AIRBORNE			
a.	Particulates and radioiodine (6/12)	1, 4-9, 21, 23, 40, 48 and 57	Continuous sampling Weekly collection	Particulate: Gross beta ² , weekly; gamma isotopic ³ , quarterly composite (by location) Radioiodine: I-131 analysis, weekly
b.	Soil ¹⁰ (0/5)	9, 1, 7, 21, and 23	Annually	Gamma isotopic ³
2.	DIRECT RADIATION			
	TLD ⁴ (34/56)	1-9, 10-25, 40-47, 49-51, 53-56, 1S-16S	Quarterly, annually	Gamma, quarterly data review
3.	WATERBORNE			
a.	Surface/ Drinking ⁶ (3/4)	26, 27, 28 and 29	Composite aliquots ⁵ , monthly	Gamma isotopic ³ , Gross, tritium quarterly composite
b.	Ground water (2/3)	31, 32, and 52	Quarterly	Gamma isotopic ³ and tritium, quarterly

TABLE 5-1 (contd.)

Sample Type ¹¹	Sample Location Code ¹	Sampling and Collection Frequency ¹	Type and Frequency of Analysis ¹
WATERBORNE (contd.)			
c. Sediment from shoreline (1/2)	33 and 34	Semiannually	Gamma isotopic ³
4. INGESTION			
a. Milk ⁷ (4/5)	9, 35, 36, and 40	Semimonthly during grazing season, monthly at other times	Gamma isotopic ³ Iodine-131
b. Fish ⁸ (2/2)	30, 38, or 39	Seasonal or Semiannually	Gamma isotopic ³
c. Garden produce ⁹ (2/2)	37 and 9	Monthly during growing season in the Riverview area of Pasco and a control near Grandview	Gamma isotopic ³

*Sample locations are graphically depicted in Figures 5-1 and 5-2.

¹Deviations are permitted if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. All deviations will be documented in the Annual Radiological Environmental Monitoring Report.

²Particulate sample filters will be analyzed for gross beta after at least 24-hour decay. If gross beta activity is greater than 10 times the mean of the control sample, gamma isotopic analysis should be performed on the individual sample.

³Gamma isotopic means identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents of the facility.



TABLE 5-1 (Contd.)

⁴TLD refers to thermoluminescent dosimeter. For purposes of WNP-2 REMP, a TLD is a phosphor card (32mm x 45mm x 0.5mm) with eight individual read-out areas (four main dosimeter areas and four back-up dosimeter areas) in each badge case. TLDs used in REMP meet the requirements of Regulatory Guide 4.13 (ANSI N545-1975), except for specified energy-dependence response. Correction factors are available for energy ranges with response outside of the specified tolerances. TLD stations 1S-16S are special interest stations and are not included amongst the 34 routine TLD stations required by Plant Technical Specification, Table 3.12-1.

⁵Composite samples will be collected with equipment which is capable of collecting an aliquot at time intervals which are short relative to the compositing period.

⁶Station 26, WNP-2 makeup water intake from the Columbia River, satisfies the Technical Specification criteria for upstream surface water and drinking water control samples. Station 28, 300 Area Drinking Water Intake satisfies the Technical Specification criteria for downstream surface water and drinking water sample. Drinking water samples are not routinely analyzed for I-131 from two week composite. I-131 analysis will be performed when the calculated dose for the consumption of water is greater than 1 mrem per year to the maximum organ.

⁷Milk samples will be obtained from farms or individual milk animals which are located in sectors with high calculated annual average ground-level D/Qs and high dose potential. There are no milk animals located within 5 km of WNP-2. If Cesium-134 or Cesium-137 is measured in an individual milk sample in excess of 30 pCi/l, then Strontium-90 analysis should be performed.

⁸There are no commercially important species in the Hanford reach of the Columbia River. Most recreationally important species in the area are anadromous, primarily salminoids. Four fish specimen will normally be collected by electroshock technique in the vicinity of the plant discharge (Station 30). If electroshocking produces insufficient fish samples, anadromous species may be obtained from Ringold Fish Hatchery (Station 39). Control samples are normally collected in the vicinity of Ice Harbor Dam (salminoids may be obtained through the National Marine Fisheries Service at Lower Granite Dam).

⁹Garden produce will routinely be obtained from farms or gardens using Columbia River water for irrigation. One sample of a root crop, leafy vegetable, and a fruit should be collected each sample period if available. The variety of the produce sample will be dependent on seasonal availability.

¹⁰Soil samples are collected to satisfy the requirements of the Site Certification Agreement (SCA), WNP-2.

TABLE 5-1 (contd.)

¹¹The fraction in parenthesis under each sample type gives the ratio of the number of Technical Specification sample locations to the total number of sample locations for the sample type that is currently included in the overall WNP-2 radiological environmental monitoring program.

TABLE 5-2

WNP-2 REMP LOCATIONS

Station	Sector	Radial Miles ^a	TLD	AP/AI	SW	DW	GW	SE	MI	FI	GP	SO _b
1	S	1.3	0	X								X
2	NNE	1.8	0									
3	SE	2.0	X									
4	SSE	9.3	0	0								
5	ESE	7.7	0	X								
6	S	7.7	0	X								
7	WNH	2.7	0	X								X
8	ESE	4.7	0	0								
9A*	WSW	30.0	0	0								
9B*	WSW	35.0									0	
9C*	WSW	33.0							0			X
10	E	3.1	0									
11	ENE	3.1	X									
12	NNW	6.1	X									
13	SW	1.4	0									
14	WSW	1.4	0									
15	W	1.4	0									
16	WNW	1.4	0									
17	NNW	1.2	0									



TABLE 5-2
(Continued)

Station	Sector	Radial Miles ^a	TLD	AP/AI	SW	DW	GV	SE	MI	FI	GP	SO _b
18	N	1.1	0									
19	NE	1.8	0									
20	ENE	1.9	0									
21	ENE	1.5	X	X								X
22	E	2.1	0									
23	ESE	3.0	X	X								X
24	SE	1.9	0									
25	SSE	1.6	0									
26*	E	3.2			0	0						
27	E	3.2			X							
28	SSE	7.4			0	0						
29	SSE	11.0				0						
30	E	3.5								0		
31	E	1.1					0					
32	E	1.2					X					
33*	ENE	3.3						X				
34	ESE	3.3						0				
35	ENE	10.5							0			
36	ESE	7.2							0			
37A	SSE	17.0									0	
37B	SSE	16.0									X	
38*	E	26.5 (95.0)								0		



TABLE 5-2
(Continued)

Station	Sector	Radial Miles ^a	TLD	AP/AI	SW	DW	GI	SE	MI	FI	GP	SO _b
39	NE	4.3								X		
40	SE	6.4	0	0					0			
41	SE	5.8	0									
42	ESE	5.6	0									
43	E	5.7	0									
44	ENE	5.7	0									
45	ENE	4.2	0									
46	NE	4.7	0									
47	N	0.5	X									
48	NE	4.3		0								
49	NW	1.2	0									
50	SSW	1.2	0									
51	ESE	2.1	0									
52	N	0.1					0					
53	N	7.5	0									
54	INE	6.5	0									
55	SSE	7.0	0									
56	SSW	7.0	0									
57	N	0.7		0								



TABLE 5-2
(Continued)

Station	Sector	Radial Miles ^a	TLD	AP/AI	SW	DW	GW	SE	MI	FI	GP	SO _b
1S	N	0.3	X									
2S	NNE	0.4	X									
3S	NE	0.5	X									
4S	ENE	0.4	X									
5S	E	0.4	X									
6S	ESE	0.4	X									
7S	SE	0.5	X									
8S	SSE	0.7	X									
9S	S	0.7	X									
10S	SSW	0.8	X									
11S	SW	0.7	X									
12S	WSW	0.5	X									
13S	W	0.5	X									
14S	WNW	0.5	X									
15S	NW	0.5	X									
16S	NNW	0.4	X									

*Control location.

X-Sample collected at station (non-RETS)

O-Radiological Environmental Technical Specification (RETS) sample collected at station.

^aEstimated from center of WNP-2 Containment from map positions.

^bIncluded in sampling program to satisfy requirements for Site Certification Agreement with the State of Washington.

AP/AI = Air Particulate and Iodine

SW = Surface Water (River Water)

DW = Drinking Water

GW = Ground Water

SE = Shoreline Sediment

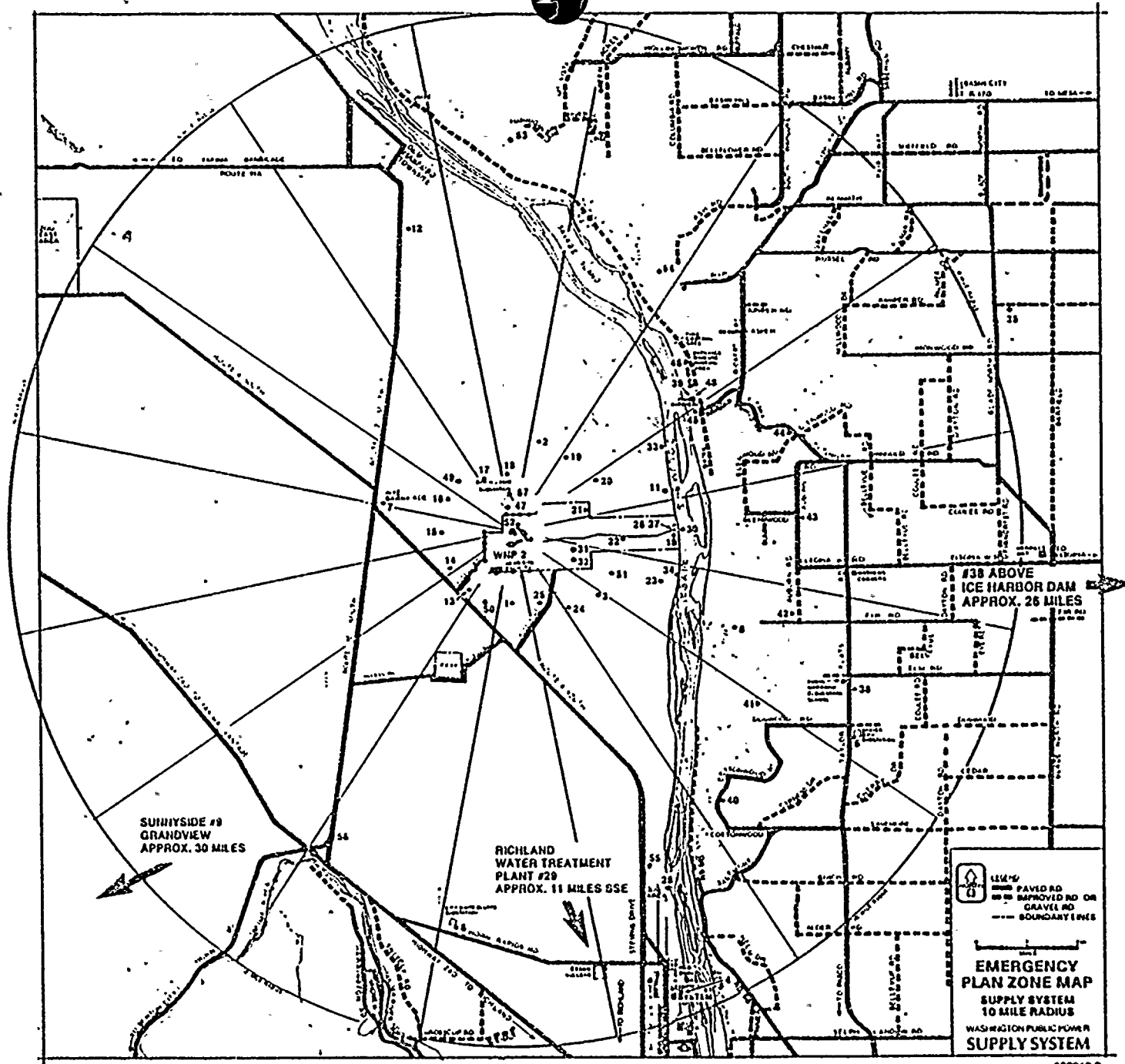
MI = Milk

FI = Fish

GP = Garden Produce

SO = Soil





RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS INSIDE OF 10 MILE RADIUS

Figure 5-1

6.0 SEMI-ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Routine Radioactive Effluent Release Reports covering the operation of WNP-2 during the previous 6 months of operation are submitted within 60 days after January 1 and July 1 of each year.

These reports shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit (WNP-2). Reports shall include each class of solid waste (as defined by 10 CFR 61) shipped offsite during the reporting period with the following information; container volume, total curie quantity, principal radionuclides, source of waste and processing employed, container type, and solidification agent or absorbent.

The Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid made during the reporting period.

The Radioactive Effluent Release Reports include any changes made during the reporting period to the Process Control Program and to the ODCM pursuant to Technical Specification 6.13 and 6.14, respectively, as well as any major change to Liquid, Gaseous, or Solid Radwaste Treatment System, pursuant to Technical Specification 6.15. It also includes a listing of new locations for dose calculations and or environmental monitoring identified by the Land Use Census pursuant to Technical Specification 3.12.2.

The Radioactive Effluent Release Reports also include an explanation as to why the inoperability of liquid or gaseous effluent monitoring instrumentation was not corrected within the time specified in Technical Specification 3.3.7.11 or 3.3.7.12, respectively; and a description of the events leading to liquid holdup tanks exceeding the limits of Technical Specification 3.11.1.4.



The Radioactive Effluent Report to be submitted within 60 days after January 1 of each year includes an annual summary of meteorological data collected over the previous year. This annual summary will be in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. This same report includes an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit during the previous calendar year. This same report also includes, an assessment of the radiation doses from radioactive liquid and gaseous effluents to Members of the Public due to their activities inside the Site Boundary during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, are included in these reports.

The assessment of radiation doses is performed in accordance with the methodology and parameters in the ODCM.

The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year also includes, as required by Technical Specification 3.11.4, an assessment of radiation doses to the likely most exposed Member of the Public from WNP-2 reactor releases and other nearby uranium fuel cycle sources, including doses from primary effluent pathways and direct radiation, for the previous calendar year to show conformance with 40 CFR 190, "Environmental Radiation Protection Standards for Nuclear Power Operation".

