OFFSITE DOSE CALCULATION MANUAL - TABLE OF CONTENTS

SECTION **PAGE**

1.0 RECORD OF REVISION 2

2.0 LIQUID EFFLUENT CALCULATIONS 3

2.1 Monitor Alarm Setpoint Determination 3

2.2 Liquid Effluent Concentration - Compliance With 10CFR20 11

2.3 Liquid Effluent Doses - Compliance With 10CFR50 12

2.4 References 15

Figure 1 Radwaste Clean, Dirty, Solid Waste 16

Table 1 Liquid Source Terms 17

Table 2 Aij Values for the Monticello Nuclear Generating Plant (mrem/hr per mCi/ml) 18

Prepared By:	
Reviewed By:	
OC Final Review Meeting:	Date:
Approved By Plant Manager:	Date:

FOR ADMINISTRATIVE USE ONLY			
3087 (DOCUMENT CHANGE, HOLD, AND COMMENT FORM) incorporated:			
Resp Supv: CHEM	Assoc Ref: CHEM-I	SR: N	Freq: 2 yrs
ARMS: ODCM-04.01	Doc Type: 7030	Admin Initials:	Date:

I/plr

1.0 RECORD OF REVISION

Revision No.	Date	Reason for Revision
1	October - 2000	Moved previous ODCM-02.01 (LIQUID EFFLUENTS) into this section and renamed this section "LIQUID EFFLUENTS CALCULATIONS" to facilitate moving the Radiological Effluents Tech Specs to the ODCM. Removed dilution flow from setpoint calculations for the Service Water and Turbine Normal Drain Monitors to ensure the setpoints are valid for all plant modes. Revised the Table 1 MPC_i values to 10 times the concentration values of 10CFR20.1001-20.2402, Table 2, Column 2.
2	November - 2001	Added clarification of use of computer program LIQDOS to section 2.0. Changed Turbine Building Normal Drain Sump to Turbine Building Normal Waste Sump.

2.0 LIQUID EFFLUENT CALCULATIONS

It is MNGP's policy to make no routine liquid releases, this section is used to:

A. Determine alarm setpoints for liquid monitors;

B. Determine that liquid concentrations in effluents are below 10 times the allowable concentrations given in 10CFR20;

C. Calculate dose commitments to individuals; and

D. Project doses for the next month due to liquid radioactive effluents.

E. Enter and compute liquid effluent doses using the LIQDOS Program if liquid effluent releases are made.

2.1 Monitor Alarm Setpoint Determination

Monitor alarm setpoints are determined to assure compliance with Tech Specs. The setpoints indicate if the concentration of radionuclides in the liquid effluent at the site boundary exceeds 10 times the concentrations specified in Appendix B, Table 2, Column 2 of 10CFR20.1001-20.2402 for radionuclides other than dissolved or entrained noble gases. The setpoints will also assure that a concentration of 2×10^{-4} μCi/ml for dissolved or entrained noble gases is not exceeded.

Monitor alarm setpoints are calculated monthly. The calculation is performed by the LIQDOS computer program. The calculation is based on radionuclides detected in effluent from the release point during the previous month in the following manner:

A. If there were no detectable radionuclides during the previous month, the BWR GALE Code source terms (Table 1)(2) will be used as the basis for the monthly release rate.

B. If the calculated setpoint is less than the existing monitor setpoint, the setpoint will be reduced to the new lower value.

C. If the calculated setpoint is greater than the existing monitor setpoint, the setpoint may remain at the lower value or be increased to the new value.

2.1.1 Radwaste Discharge Line Monitor

The following method applies to liquid releases from the plant via the discharge canal when determining the high-high alarm setpoint for the Liquid Radwaste Effluent Monitor during all operational conditions. The radwaste discharge flowrate is assumed to be maintained relatively constant at or near the maximum Liquid Radwaste Pump design flowrate. Circulating water is used for dilution because the setpoint is applied at the liquid effluent site boundary (ODCM-02.01, Figure 1).

A. Determine the "mix" (radionuclides and composition) of the liquid effluent.

1. Determine the liquid source terms that are representative of the "mix" of the liquid effluent. Liquid source terms are the total curies of each isotope released during the previous month. Table 1 source terms may be used if there have been no liquid releases.

2. Determine S_i (the fraction of the total radioactivity in the liquid effluent comprised by radionuclide i) for each individual radionuclide in the liquid effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \qquad 2.1\text{-}1$$

where

A_i = The radioactivity of radionuclide i in the liquid effluent from Table 1.

B. Determine C_t, the maximum acceptable total radioactivity concentration of all radionuclides in the liquid effluent prior to dilution (μCi/ml).

$$C_t = \frac{F}{f \sum_i \frac{S_i}{MPC_i}} \qquad 2.1\text{-}2$$

where

F = Dilution water flowrate (gpm):

= Current circulating water flowrate or 240,000 gpm from two circulating water pumps, whichever is less.

f = The maximum acceptable discharge flowrate prior to dilution (gpm);

= 50 gpm from the Liquid Radwaste Pump (3);

and

MPC_i = The liquid effluent radioactivity concentration limit for radionuclide i (μCi/ml) from Table 1.

C. Determine C_m, the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) in the liquid discharge prior to dilution (μCi/ml).

$$C_m = C_t - (C_t S_H) \qquad 2.1\text{-}3$$

where

S_H = The fraction of the total radioactivity in the liquid effluent comprised of tritium and other radionuclides that do not emit gamma or x ray radiation.

D. Determine C.R., the calculated monitor count rate above background attributed to the radionuclides (ncps).

$$C.R. = \frac{C_m}{E} \qquad 2.1\text{-}4$$

where

E = The detection efficiency of the monitor (μCi/cc/cps) from Plant Chemistry Surveillance procedures.

E. The monitor high-high alarm setpoint above background (ncps) should be set at or less than the C.R. value. Since only one tank can be released at a time, adjustment of this value is not necessary to compensate for releases from more than one source.

2.1.2 Discharge Canal Monitor

The following method determines the high-high alarm setpoint for the Discharge Canal Monitor during all operational conditions.

A. Determine the “mix” (radionuclides and composition) of all liquids released into the discharge canal.

1. Determine the liquid source terms that are representative of the “mix” of all liquid released into discharge canal. Liquid source terms are the total curies of each isotope released during the previous month. Table 1 source terms may be used if there have been no liquid releases.

2. Determine S_i, the fraction of the total radioactivity of all liquids released into the discharge canal comprised by radionuclide i for each individual radionuclide released into the discharge canal.

$$S_i = \frac{A_i}{\Sigma A_i} \qquad 2.1\text{-}5$$

where

A_i = The radioactivity of radionuclide i released into the discharge canal.

B. Determine C_d, the maximum acceptable total radioactivity concentration of all radionuclides released into the discharge canal (μCi/ml).

$$C_d = \frac{1}{\sum_i \frac{S_i}{MPC_i}} \qquad 2.1\text{-}6$$

where

MPC_i = The liquid effluent radioactivity concentration limit for radionuclide i (μCi/ml) from Table 1.

C. Determine C_m, the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) released into the discharge canal (μCi/ml).

$$C_m = C_d - (C_d S_H) \qquad 2.1\text{-}7$$

where

S_H = The fraction of the total radioactivity released into the discharge canal comprised of tritium and other radionuclides that do not emit gamma or x-ray radiation.

D. Determine C.R., the calculated monitor count rate above background attributed to the radionuclides (ncps).

$$C.R. = \frac{C_m}{E} \qquad 2.1\text{-}8$$

where

E = The detection efficiency of the monitor (μCi/cc/cps) from Plant Chemistry Surveillance procedures.

E. The monitor high-high alarm setpoint above background (ncps) should be set at or less than the C.R. value.

2.1.3 Service Water Discharge Pipe Monitor

Dilution flow is not used for the service water discharge pipe monitor setpoint determination to ensure the setpoint is valid for all modes of plant operation. The following method determines the high-high alarm setpoint for the Service Water Discharge Pipe Monitor during all operational conditions.

A. Determine the “mix” (radionuclides and composition) of the service water effluent.

1. Determine the liquid source terms that are representative of the “mix” of the service water effluent. Liquid source terms are the total curies of each isotope released during the previous month. Table 1 source terms may be used if there have been no liquid releases.

2. Determine S_i the fraction of the total radioactivity in the service water effluent comprised by radionuclide i, for each individual radionuclide in the liquid effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \qquad 2.1\text{-}9$$

where

A_i = The radioactivity of radionuclide i in the service water effluent.

B. Determine C_t, the maximum acceptable total radioactivity concentration of all radionuclides in the service water effluent prior to dilution (μCi/ml).

$$C_t = \frac{1}{\sum_i \frac{S_i}{MPC_i}} \qquad 2.1\text{-}10$$

where

MPC_i = The liquid effluent radioactivity concentration limit for radionuclide i (μCi/ml) from Table 1.

C. Determine C_m, the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) in the service water prior to dilution (μCi/ml).

$$C_m = C_t - (C_t S_H) \qquad 2.1\text{-}11$$

where

S_H = The fraction of the total radioactivity in the service water effluent comprised of tritium and other radionuclides that do not emit gamma or x-ray radiation.

D. Determine C.R., (the calculated monitor count rate above background attributed to the radionuclides (ncps)).

$$C.R. = \frac{C_m}{E} \qquad 2.1\text{-}12$$

where

E = The detection efficiency of the monitor (μCi/cc/cps) from Plant Chemistry Surveillance procedures.

E. The monitor high-high alarm setpoint above background (ncps) should be set at or less than the C.R. value.

2.1.4 Turbine Building Normal Waste Sump Monitor

Dilution flow is not used for the Turbine Building Normal Waste Sump Monitor setpoint determination to ensure the setpoint is valid for all modes of plant operation. The following method determines the high-high alarm setpoint for the Turbine Building Normal Waste Sump Monitor during all operational conditions.

A. Determine the “mix” (radionuclides and composition) of the TBNWS effluent.

1. Determine the liquid source terms that are representative of the “mix” of the TBNWS effluent. Liquid source terms are the total curies of each isotope released during the previous month. Table 1 source terms may be used if there have been no liquid releases.

2. Determine S_i, the fraction of the total radioactivity in the TBNWS effluent comprised by radionuclide i, for each individual radionuclide in the liquid effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \qquad 2.1\text{-}13$$

where

A_i = The radioactivity of radionuclide i in the TBNWS effluent.

B. Determine C_t, the maximum acceptable total radioactivity concentration of all radionuclides in the TBNWS effluent prior to dilution (μCi/ml).

$$C_t = \frac{1}{\sum_i \frac{S_i}{MPC_i}} \qquad 2.1\text{-}14$$

MPC_i = The liquid effluent radioactivity concentration limit for radionuclide i (μCi/ml) from Table 1.

C. Determine C_m, the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) in the TBNWS prior to dilution (μCi/ml).

$$C_m = C_t - (C_t S_H) \qquad 2.1\text{-}15$$

where

S_H = The fraction of the total radioactivity in the TBNWS effluent comprised of tritium and other radionuclides that do not emit gamma or x-ray radiation.

D. Determine C.R., the calculated monitor count rate above background attributed to the radionuclides (ncps).

$$C.R. = \frac{C_m}{E} \qquad 2.1\text{-}16$$

where

E = The detection efficiency of the monitor (μCi/cc/cps) from Plant Chemistry Surveillance procedures.

E. The monitor high-high alarm setpoint above background (ncps) should be set at or less than the C.R. value.

2.1.5 Multiple Release Points

The discharge canal monitor, service water discharge and TBNWS line monitor are provided to detect unplanned or accidental releases. All normal releases are monitored by the radwaste discharge line monitor. There are, therefore, no multiple release points and monitor settings do not have to be reduced to account for multiple releases.

2.2 Liquid Effluent Concentration - Compliance With 10CFR20

In order to demonstrate compliance with 10CFR20, the concentrations of radionuclides in liquid effluents are determined and compared to 10 times the concentrations specified in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402. The concentration of radioactivity in effluents prior to dilution is determined. The concentration in diluted effluent is calculated by the LIQDOS computer program.

2.2.1 Batch Releases

A. Prerelease

The radioactivity content of each batch release is determined prior to release. MNGP will show compliance with Tech Specs (TS) in the following manner:

The concentration of the various radionuclides in the batch release prior to dilution flow to obtain the concentration at the unrestricted area. This calculation is shown in the following equation:

$$Conc_i = \frac{C_i\,R}{MDF} \qquad 2.2\text{-}1$$

where

$Conc_i$ = concentration of radionuclide i at the unrestricted area, (μCi/ml);

C_i = concentration of radionuclide i in the potential batch release, (μCi/ml);

R = release rate of the batch, (gpm);

MDF = minimum dilution flow, (gpm).

The projected concentration in the unrestricted area is compared to 10 times the concentrations specified in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402. These concentrations are given in Table 1. Before a release may occur, Equation 2.2-2 must be met for all nuclides. For the MNGP the MDF is 240,000 gpm. The maximum release rate is 50
gpm.

$$\sum_i \frac{Conc_i}{MPC_i} \leq 1 \qquad 2.2\text{-}2$$

where

MPC_i = maximum concentration of radionuclide i from Table 1, (μCi/ml).

2.3 Liquid Effluent Doses - Compliance With 10CFR50

Doses resulting from liquid effluents are calculated monthly to show compliance with 10CFR 50. These calculations are performed by the LIQDOS computer program. A cumulative summation of total body and organ doses for each calendar quarter and calender year is maintained as well as projected doses for the next month.

2.3.1 Determination of Liquid Effluent Dilution

To determine doses from liquid effluents the near field average dilution factor for the period of release must be calculated. This dilution factor must be calculated for each bath release. The dilution factor is determined by:

$$F_k = \frac{R_k}{X\ ADF_k} \qquad 2.3\text{-}1$$

where

R_k = release rate of the batch during time period k, (gpm);

and

ADF_k = actual dilution flow during the time period of release k, (gpm).

The value of X is the site specific value for the mixing effect of the MNGP discharge structure. This value is 1.0 for MNGP while operating in the once-through cooling mode. Although not expected to occur, if radioactive material is discharged while operating in the recycle mode, this value may be 1.86. [4]

2.3.2 Dose Calculations

The dose contribution from the release of liquid effluents is calculated monthly. The dose contribution is calculated using the following equation:

$$D_j = \sum_k \sum_i A_{ij} t_k C_{ik} F_k \qquad 2.3\text{-}2$$

where

D_j = the dose commitment to the total body or any organ, from the liquid effluents for the 31 day period, (mrem);

C_{ik} = the average concentration of radionuclide, i, in undiluted liquid effluent for release k, (μCi/ml);

A_{ij} = the site related ingestion dose commitment factor to the total body or any organ j for each identified principal gamma and beta emitter, (mrem/hr per μCi/ml);

F_k = the near field average dilution factor for C_{ik} during liquid effluent release k, as defined in Equation 2.3-1, and

t_k = the length of time for release k, (hours).

The dose factor A_{ij} was calculated for an adult for each isotope using the following equation:

$$A_{ij} = 1.14 \times 10^5 \, (730/D_w + 21BF_i) \, DF_{ij} \qquad 2.3\text{-}3$$

where

$$1.14 \times 10^5 = \frac{10^6 \text{pCi}}{\mu\text{Ci}} \quad \frac{10^3 \text{ml}}{\text{liter}} \quad \frac{1 \text{ yr}}{8760 \text{ hr}}$$

730 = adult water consumption rate, (liters/yr);

D_w = dilution factor from the near field area to the potable water intake for adult water consumption;

21 = adult fish consumption, (kg/yr);

BF_i = bioaccumulation factor for radionuclide i in fish from Table A-1 of Regulatory Guide 1.109 Rev. 1, [5] (pCi/kg per pCi/liter);

DF_{ij} = dose conversion factor for radionuclide i for adults for particular organ j from Table E-11 of Regulatory Guide 1.109 Rev. 1, (mrem/pCi).

The A_{ij} values for an adult at the MNGP are given in Table 2. The far field dilution factor, D_w for the MNGP is 7:1 for the nearest downstream water supply in St. Paul. This value was determined by assuming that effluents are completely mixed in 50% of the Mississippi River flow (7431 cfs at Anoka, MN). [6]

2.3.3 Cumulation of Doses

Doses calculated monthly are summed for comparison with quarterly and annual limits. The monthly results should be added to the doses cumulated from the other months in the quarter of interest and in the year of interest. This summation is performed by the LIQDOS computer program.

For the quarter:

$D \leq 1.5$ mrem total body 2.3-4

$D \leq 5$ mrem any organ 2.3-5

For the Calendar Year,

$D \leq 3$ mrem total body 2.3-6

$D \leq 10$ mrem any organ 2.3-7

The quarterly limits given above represent one half of the annual design objective.(7) If these quarterly or annual limits are exceeded, a special report should be submitted stating the reason and corrective action to be taken. This report will include results of analysis of Mississippi River water and an analysis of possible impacts through the drinking water pathway. If twice these limits are exceeded, a special report will be submitted showing compliance with 40CFR190. (8)

2.3.4 Projection of Doses

Anticipated doses resulting from the release of liquid effluents are projected monthly. If the projected doses for the month exceed 2% of Equation 2.3-6 or 2.3-7, additional components of the liquid radwaste treatment system will be used to process waste. The projected doses are calculated using Equation 2.3-2. This calculation is performed by the LIQDOS computer program. The dilution factor, F_k, is calculated by replacing the term ADF_k in Equation 2.3-1 with the term MDF from Equation 2.2-1.

The total source term utilized for the most recent dose calculation should be used for the projections unless information exists indicating that actual releases could differ significantly in the next month. In this case, the source term would be adjusted to reflect this information and the justification for the adjustment noted. This adjustment should account for any radwaste equipment which was operated during the previous month that could be out of service in the coming month.

2.4 References

1. USNRC, Title 10, Code of Federal Regulation, Part 20.1001-20.2402, "Standards for Protection Against Radiation", Appendix B, Table II, Column 2.

2. NSP - Monticello Nuclear Generating Plant, Appendix I Analysis - Supplement No. 1 - Docket No. 50-263, Table 2.1-2.

3. NSP - Monticello Nuclear Generating Plant, Appendix I Analysis - Supplement No. 1 - docket No. 50-263, Table 2.1-1.

4. Boegli, J.S., et. al. Eds, Section 4.3 in "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG-0133, 1978, NTIS, Springfield, VA.

5. USNRC, Regulatory Guide 1.109. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I", Rev. 1, Oct. 1977, USNRC, Washington, DC.

6. NSP - Monticello Nuclear Generating Plant, Final Draft Safety Analysis Report - Amendment 4, Question 3.3, and Amendment 8 in entirety.

7. USNRC, Title 10, Code of Federal Regulation, Part 50, "Domestic Licensing of Production and Utilization Facilities", Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion As Low as is Reasonably Achievable for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents".

8. EPA, Title 40, Code of Federal Regulations, Part 190 "Environmental Radiation Protection Standards for Nuclear Power Operations".

Figure 1 Radwaste Clean, Dirty, Solid Waste

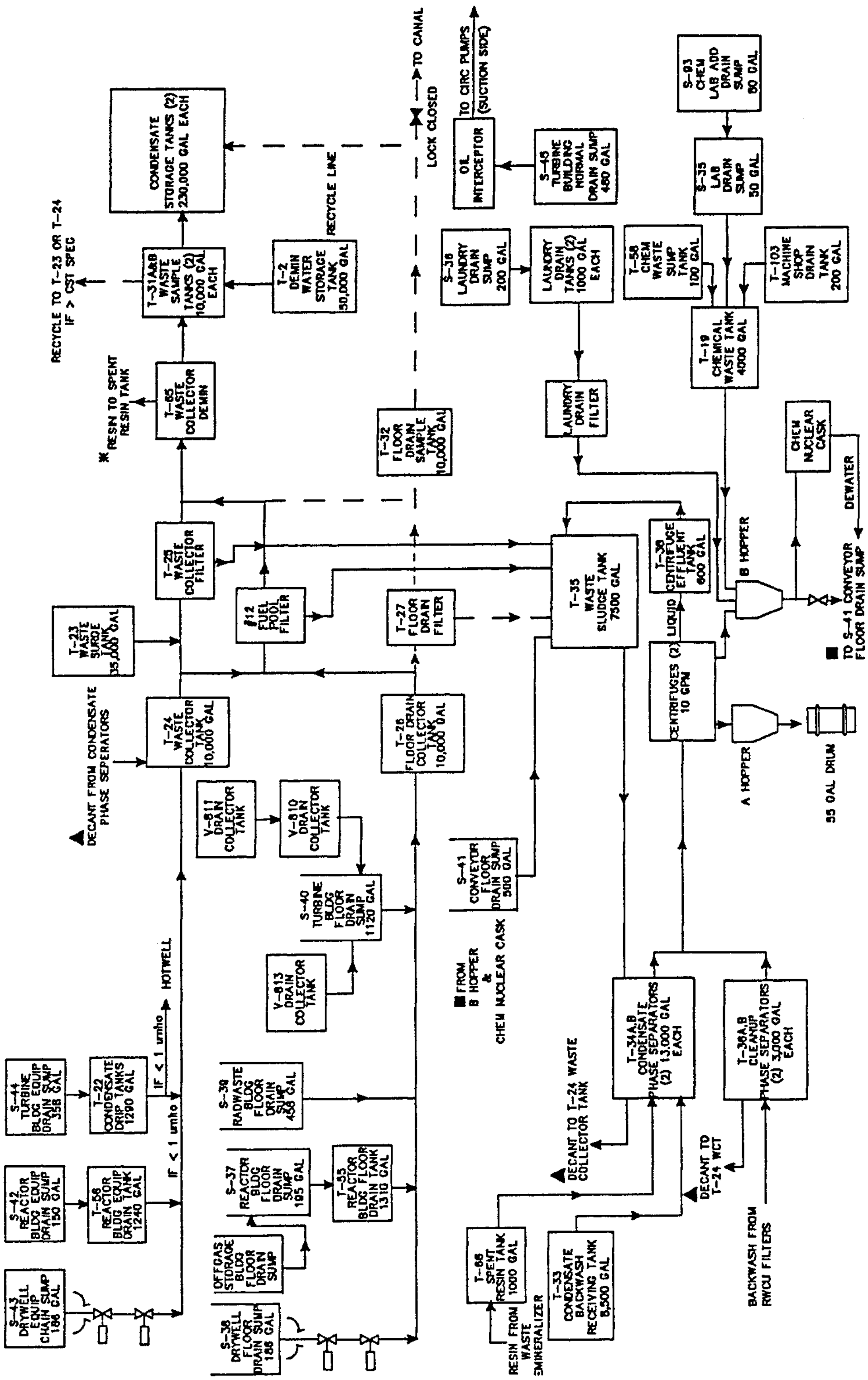

Table 1 Liquid Source Terms

Radionuclide	Radioactivity A_i Ci/yr*	MPC_i μCi/ml**
H-3	2.1E 1	1E-2
Na-24	1.7E-1	5E-4
Mn-54	2.6E-3	3E-4
Mn-56	2.7E-1	7E-4
Fe-59	8.1E-4	1E-4
Co-58	9.3E-3	2E-4
Co-60	2.0E-2	3E-5
Cu-64	5.4E-1	2E-3
Zn-65	5.3E-3	5E-5
Zn-69m	3.7E-2	6E-4
Br-83	1.4E-2	9E-3
Sr-89	2.8E-3	8E-5
Sr-90	1.7E-4	5E-6
Sr-91	6.4E-2	2E-4
Sr-92	5.8E-2	4E-4
Y-92	1.0E-1	4E-4
Y-93	6.6E-2	2E-4
Mo-99	5.0E-2	2E-4
I-131	1.3E-1	1E-5
I-132	1.3E-1	1E-3
I-133	4.0E-1	7E-5
I-134	6.4E-2	4E-3
I-135	2.5E-1	3E-4
Cs-134	8.3E-2	9E-6
Cs-136	2.6E-2	6E-5
Cs-137	1.2E-1	1E-5
Cs-138	1.5E-1	4E-3
Ba-140	1.1E-2	8E-5
La-141	5.7E-3	5E-4
Ce-141	8.5E-4	3E-4
Ce-144	5.3E-3	3E-5
Np-239	1.7E-1	2E-4
Noble Gases	-	
Total	2.40E1	

* These source terms were calculated in accordance with NUREG-0016 by using the USNRC "GALE" Code.

** MPC_i Values are 10 times the concentration values of 10CFR20.1001 - 20.2402 Table 2 Column 2.

l/plr

Table 2 A_{ij} Values for the Monticello Nuclear Generating Plant (mrem/hr per μCi/ml)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
1 H-3	0.00E 00	1.47E 00	1.47E 00	1.47E 00	1.47E 00	1.47E 00	1.47E 00
6 C 14	3.13E 04	6.26E 03	6.26E 03	6.26E 03	6.26E 03	6.26E 03	6.26E 03
11 Na-24	4.27E 02	4.27E 02	4.27E 02	4.27E 02	4.27E 02	4.27E 02	4.27E 02
24 Cr-51	0.00E 00	0.00E 00	1.31E 00	7.80E 01	2.38E 01	1.73E 00	3.28E 02
25 Mn-54	0.00E 00	4.43E 02	8.45E 02	0.00E 00	1.32E 03	0.00E 00	1.36E 04
25 Mn-56	0.00E 00	1.11E 02	1.98E 01	0.00E 00	1.42E 02	0.00E 00	3.56E 03
26 Fe-55	6.91E 02	4.77E 02	1.11E 02	0.00E 00	0.00E 00	2.66E 02	2.74E 02
26 Fe-59	1.09E 03	2.56E 03	9.83E 02	0.00E 00	0.00E 00	7.16E 02	8.54E 03
27 Co-58	0.00E 00	9.80E 01	2.20E 02	0.00E 00	0.00E 00	0.00E 00	1.99E 03
27 Co-60	0.00E 00	2.82E 02	6.21E 02	0.00E 00	0.00E 00	0.00E 00	5.29E 03
28 Ni-63	3.27E 04	2.26E 03	1.10E 03	0.00E 00	0.00E 00	0.00E 00	4.72E 02
28 Ni-65	1.33E 02	1.72E 01	7.87E 00	0.00E 00	0.00E 00	0.00E 00	4.37E 02
29 Cu-64	0.00E 00	1.10E 01	5.15E 00	0.00E 00	2.76E 01	0.00E 00	9.34E 02
30 Zn-65	2.32E 04	7.39E 04	3.34E 04	0.00E 00	4.94E 04	0.00E 00	4.66E 04
30 Zn-69	4.94E 01	9.46E 01	6.58E 00	0.00E 00	6.14E 01	0.00E 00	1.42E 01
35 Br-83	0.00E 00	0.00E 00	4.09E 01	0.00E 00	0.00E 00	0.00E 00	5.89E 01
35 Br-84	0.00E 00	0.00E 00	5.30E 01	0.00E 00	0.00E 00	0.00E 00	4.16E-04
35 Br-85	0.00E 00	0.00E 00	2.18E 00	0.00E 00	0.00E 00	0.00E 00	1.02E-15
37 Rb-86	0.00E 00	1.01E 05	4.72E 04	0.00E 00	0.00E 00	0.00E 00	2.00E 04
37 Rb-88	0.00E 00	2.90E 02	1.54E 02	0.00E 00	0.00E 00	0.00E 00	4.01E-09
37 Rb-89	0.00E 00	1.92E 02	1.35E 02	0.00E 00	0.00E 00	0.00E 00	1.12E-11
38 Sr-89	2.58E 04	0.00E 00	7.40E 02	0.00E 00	0.00E 00	0.00E 00	4.14E 03
38 Sr-90	6.35E 05	0.00E 00	1.56E 05	0.00E 00	0.00E 00	0.00E 00	1.83E 04
38 Sr-91	4.75E 02	0.00E 00	1.92E 01	0.00E 00	0.00E 00	0.00E 00	2.26E 03
38 Sr-92	1.80E 02	0.00E 00	7.78E 00	0.00E 00	0.00E 00	0.00E 00	3.57E 03

Table 2 A_{ij} Values for the Monticello Nuclear Generating Plant (mrem/hr per μCi/ml) (cont'd)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
39 Y-90	6.90E-01	0.00E 00	1.35E-02	0.00E 00	0.00E 00	0.00E 00	7.32E 03
39 Y-91m	6.52E-03	0.00E 00	2.53E-04	0.00E 00	0.00E 00	0.00E 00	1.92E-02
39 Y-91	1.01E 01	0.00E 00	2.70E-01	0.00E 00	0.00E 00	0.00E 00	5.57E 03
39 Y-92	6.06E-02	0.00E 00	1.77E-03	0.00E 00	0.00E 00	0.00E 00	1.06E 03
39 Y-93	1.92E-01	0.00E 00	5.31E-03	0.00E 00	0.00E 00	0.00E 00	6.10E 03
40 Zr-95	6.02E-01	1.93E-01	1.31E-01	0.00E 00	3.03E-01	0.00E 00	6.11E 02
40 Zr-97	3.32E-02	6.71E-03	3.07E-03	0.00E 00	1.01E-02	0.00E 00	2.08E 03
41 Nb-95	4.47E 02	2.49E 02	1.34E 02	0.00E 00	2.46E 02	0.00E 00	1.51E 06
42 Mo-99	0.00E 00	1.54E 02	2.94E 01	0.00E 00	3.50E 02	0.00E 00	3.58E 02
43 Tc-99m	1.13E-02	3.34E-02	4.25E-01	0.00E 00	5.07E-01	1.63E-02	1.97E 01
43 Tc-101	1.21E-02	1.75E-02	1.72E-01	0.00E 00	3.15E-01	8.94E-03	5.26E-14
44 Ru-103	6.63E 00	0.00E 00	2.86E 00	0.00E 00	2.53E 01	0.00E 00	7.74E 02
44 Ru-105	5.52E 01	0.00E 00	2.18E-01	0.00E 00	7.13E 00	0.00E 00	3.38E 02
44 Ru-106	9.85E 01	0.00E 00	1.25E 01	0.00E 00	1.90E 02	0.00E 00	6.38E 03
47 Ag-110m	2.78E 00	2.57E 00	1.53E 00	0.00E 00	5.06E 00	0.00E 00	1.05E 03
52 Te-125m	2.60E 03	9.41E 02	3.48E 02	7.81E 02	1.06E 04	0.00E 00	1.04E 04
52 Te-127m	6.56E 03	2.35E 03	8.00E 02	1.68E 03	2.67E 04	0.00E 00	2.20E 04
52 Te-127	1.07E 02	3.83E 01	2.31E 01	7.90E 01	4.34E 02	0.00E 00	3.42E 03
52 Te-129m	1.11E 04	4.16E 03	1.76E 03	3.83E 03	4.65E 04	0.00E 00	5.61E 04
52 Te-129	3.04E 01	1.14E 01	7.42E 00	2.34E 01	1.23E 02	0.00E 00	2.30E 01
52 Te-131m	1.68E 03	8.20E 02	6.83E 02	1.30E 03	9.31E 03	0.00E 00	8.14E 04
52 Te-131	1.81E 01	7.98E 00	6.03E 00	1.57E 01	8.37E 01	0.00E 00	2.70E 00
52 Te-132	2.44E 03	1.58E 03	1.48E 03	1.75E 03	1.52E 04	0.00E 00	7.47E 04
53 I-130	3.61E 01	1.07E 02	4.21E 01	9.03E 03	1.66E 02	0.00E 00	9.18E 01
53 I-131	1.99E 02	2.84E 02	1.63E 02	9.32E 04	4.88E 02	0.00E 00	7.50E 01
53 I-132	9.70E 00	2.60E 01	9.08E 00	9.08E 02	4.13E 01	0.00E 00	4.88E 00
53 I-133	6.79E 01	1.18E 02	3.60E 01	1.74E 04	2.06E 02	0.00E 00	1.06E 02
53 I-134	5.07E 00	1.38E 01	4.92E 00	2.39E 02	2.19E 01	0.00E 00	1.20E-02
53 I-135	2.12E 01	5.54E 01	2.05E 01	3.66E 03	8.89E 01	0.00E 00	6.26E 01

Table 2 A_{ij} Values for the Monticello Nuclear Generating Plant (mrem/hr per μCi/ml) (cont'd)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
55 Cs-134	2.99E 05	7.10E 05	5.81E 05	0.00E 00	2.30E 05	7.63E 04	1.24E 04
55 Cs-136	3.12E 04	2.23E 05	8.88E 04	0.00E 00	6.86E 04	9.41E 03	1.40E 04
55 Cs-137	3.83E 05	5.23E 05	3.43E 05	0.00E 00	1.78E 05	5.90E 04	1.01E 04
55 Cs-138	2.65E 02	5.23E 02	2.59E 02	0.00E 00	3.84E 02	3.80E 01	2.23E-03
56 Ba-139	2.08E 00	1.48E-03	6.10E-02	0.00E 00	1.39E-03	8.41E 04	3.69E 00
56 Ba-140	4.36E 02	5.47E-01	2.85E 01	0.00E 00	1.86E-01	3.13E 01	8.97E 02
56 Ba-141	1.01E 00	7.64E-04	3.41E-02	0.00E 00	7.10E-04	4.34E 04	4.77E-10
56 Ba-142	4.57E-01	4.70E-04	2.88E-02	0.00E 00	3.97E-04	2.66E 04	6.44E-19
57 La-140	1.79E-01	9.04E-02	2.39E-02	0.00E 00	0.00E 00	0.00E 00	6.64E 03
57 La-142	9.18E-03	4.18E-03	1.04E-03	0.00E 00	0.00E 00	0.00E 00	3.05E 01
58 Ce-141	1.34E-01	9.04E-02	1.03E-02	0.00E 00	4.20E-02	0.00E 00	3.46E 02
58 Ce-143	2.36E-02	1.74E 01	1.93E-03	0.00E 00	7.67E-03	0.00E 00	6.51E 02
58 Ce-144	6.97E 00	2.91E 00	3.74E-01	0.00E 00	1.73E 00	0.00E 00	2.36E 03
59 Pr-143	6.60E-01	2.65E-01	3.27E-02	0.00E 00	1.53E-01	0.00E 00	2.89E 03
59 Pr-144	2.16E-03	8.97E-04	1.10E-04	0.00E 00	5.06E-04	0.00E 00	3.11E-14
60 Nd-147	4.51E-01	5.22E-01	3.12E-02	0.00E 00	3.05E-01	0.00E 00	2.50E 04
74 W-187	2.97E 02	2.48E 02	8.68E 01	0.00E 00	0.00E 00	0.00E 00	8.13E 04
93 Np-239	4.26E-02	4.19E-03	2.31E-03	0.00E 00	1.31E-02	0.00E 00	8.60E 02