



May 15, 2002

Technical Specification 6.7.A.4

US Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, DC 20555

**M2002048**

**MONTICELLO NUCLEAR GENERATING PLANT**  
Docket No. 50-263 License No. DPR-22

**2001 Radioactive Effluent Release Report**

In accordance with Monticello Technical Specification Section 6.7.A.4, we are submitting the following information as attachments:


- Attachment A: Effluent Release Report for January - December 2001
- Attachment B: Off-Site Radiation Dose Assessment for January 1 - December 31, 2001
- Attachment C: Effluent and Waste Disposal Semi-Annual Report for January - June 1999  
(Updated Table 2A Liquid Effluents – Percent of Quarterly Tech Spec Reporting Level)
- Attachment D: Effluent and Waste Disposal Semi-Annual Report for January - June 2000  
(Updated Table 2A Liquid Effluents – Percent of Quarterly Tech Spec Reporting Level)
- Attachment E: Effluent and Waste Disposal Semi-Annual Report for July - December 2000  
(Updated Table 2A Liquid Effluents – Percent of Quarterly Tech Spec Reporting Level)
- Attachment F: Offsite Dose Calculation Manual (ODCM)

Past Effluent and Waste Reports were updated due to a calculation correction (Attachments C through E). The error was evaluated by our Corrective Action Program. The ODCM was revised during 2001 and the current revision is attached (Attachment F).

Please note Amendment 120 dated 07/24/01 changed our Technical Specification deadline for this report to May 15 of each year.

*IEA8  
A009*

This letter contains no new NRC commitments, nor does it modify any prior commitments.  
Please contact Paul Hartmann at (763) 271-5172 if you require further information.

A handwritten signature in black ink, appearing to read "Jeff Forbes", with a long horizontal stroke extending to the right.

Jeffrey S. Forbes  
Site Vice President  
Monticello Nuclear Generating Plant

Attachments

- c: Regional Administrator – III, NRC  
NRR Project Manager, NRC  
Resident Inspector, NRC  
Minnesota Department of Commerce

TRANSMITTAL MANIFEST  
 NUCLEAR MANAGEMENT COMPANY, LLC  
 NUCLEAR LICENSING DEPARTMENT  
 MONTICELLO NUCLEAR GENERATING PLANT

2001 Radioactive Effluent Release Report

Correspondence Date: May 15, 2002

Manifest Date: May 15, 2002

Monticello Site Distribution Special Instructions:

Melissa Miszczak.....USAR File..... Yes  No \_\_\_  
 Steve Ludders .....NRC Commitment..... Yes \_\_\_ No   
 Lila Imholte .....Monti OC Sec ..... Yes \_\_\_ No  - 12, No dist to OC members below if YES  
 Darla Minkkinen.....Monti OSRC Sec..... Yes \_\_\_ No  - 5

Monticello Site Distribution:

|                          |                                  |
|--------------------------|----------------------------------|
| J S Forbes, Site VP      | NRC Resident Inspector           |
| D P Fadel, Dir Site Engr | Monti Document Control File      |
| J D Purkis, Plant Mgr    | <i>Monti Site Licensing File</i> |
| <i>Kevin Jepsen</i>      |                                  |

NMC Distribution:

R A Anderson, Exec VP & CNO, NMC

Xcel Energy Distribution:

|                    |  |
|--------------------|--|
| S D Northard, RS-8 | Communication Dept    Yes ___ No <input checked="" type="checkbox"/> |
|--------------------|--|

External Distribution:

|                             |                             |
|-----------------------------|-----------------------------|
| Doc Control Desk, NRC       | J F Franz, OSRC Chairman    |
| Regional Admin-III, NRC     | J E Silberg                 |
| Samuel Miranda, NRR-PM, NRC | Minnesota Dept. of Commerce |

**Attachment A**

Radioactive Effluent Release Report  
for January - December 2001

(15 pages)

**NUCLEAR MANAGEMENT COMPANY**  
**MONTICELLO NUCLEAR GENERATING PLANT**  
License No. DPR-22

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Supplemental Information

1. Regulatory Limits - Quarterly levels requiring reporting to  
Nuclear Regulatory Commission

A. Noble Gases :

5 mrad/quarter gamma radiation  
10 mrad/quarter beta radiation

B. Long Lived Iodines, Particulates, and Tritium :

7.5 mrem/quarter dose to any organ

C. Liquid Effluents :

1.5 mrem/quarter dose to the total body  
5.0 mrem/quarter dose to any organ

2. Maximum Permissible Concentrations

A. Noble Gases :

10 CFR Part 20, Appendix B, Table II, Column 1

B. Long Lived Iodines, Particulates, and Tritium :

10 CFR Part 20, Appendix B, Table II, Column 1

C. Liquid Effluents :

10 CFR Part 20, Appendix B, Table II, Column 2  
2.0 E-4 uci/ml for dissolved and entrained gases

3. Average Energy

(Not Applicable)

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Supplemental Information (continued)

4. Measurements and Approximations of Total Radioactivity

A. Noble Gases :

Continuous gross activity monitors in Reactor Building Vent and Plant Stack exhaust streams. Weekly isotopic analysis of exhaust streams.

B. Iodines in Gaseous Effluent :

Continuous monitoring with charcoal cartridges in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

C. Particulates in Gaseous Effluent :

Continuous monitoring with particulate filters in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

D. Tritium in Gaseous Effluent :

Weekly grab samples from Reactor Building Vent and Plant Stack exhaust streams.

E. Liquid Effluents :

Tank sample analyzed prior to each planned release and continuous monitoring of gross activity during planned release.

5. Batch Releases

A. Liquid :

|  |     |        |
|--|-----|--------|
| 1. Number of Batch Releases                | 0   |        |
| 2. Total Time Period for Batch Releases    | 0.0 | min    |
| 3. Maximum Time Period for a Batch Release | 0.0 | min    |
| 4. Average Time Period for a Batch Release | 0.0 | min    |
| 5. Minimum Time Period for a Batch Release | 0.0 | min    |
| 6. Average River Flow During Release       | 0.0 | cf/sec |

B. Gaseous :

|  |        |     |
|--|--------|-----|
| 1. Number of Batch Releases                | 5      |     |
| 2. Total Time Period for Batch Releases    | 3545.0 | min |
| 3. Maximum Time Period for a Batch Release | 1348.0 | min |
| 4. Average Time Period for a Batch Release | 709.0  | min |
| 5. Minimum Time Period for a Batch Release | 324.0  | min |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Supplemental Information (continued)

6. Abnormal Releases

A. Liquid :

|                            |          |    |
|----------------------------|----------|----|
| 1. Number of Releases      | 2        |    |
| 2. Total Activity Released | 9.16E-07 | Ci |

B. Gaseous :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1A Gaseous Effluents - Summation of all Releases

|  | Units   | 1st Qtr  | 2nd Qtr  | Est. Total Error, % |
|--|---------|----------|----------|---------------------|
| <b>A. Fission &amp; Activation gases</b>           |         |          |          |                     |
| 1. Total Release                                   | Ci      | 2.98E+01 | 5.67E+01 | 2.00E+01            |
| 2. Average Release Rate                            | uci/sec | 3.84E+00 | 7.21E+00 |                     |
| 3. Percent Tech Spec Qtrly Reporting Level         |         |          |          |                     |
| Gamma Radiation                                    | %       | 2.83E-02 | 2.71E-02 |                     |
| Beta Radiation                                     | %       | 1.57E-02 | 1.27E-02 |                     |
| <b>B. Iodines</b>                                  |         |          |          |                     |
| 1. Total I-131 Release                             | Ci      | 5.41E-04 | 6.18E-04 | 1.00E+01            |
| 2. Average I-131 Release Rate                      | uci/sec | 6.96E-05 | 7.86E-05 |                     |
| <b>C. Particulates</b>                             |         |          |          |                     |
| 1. Total Particulates                              | Ci      | 1.76E-04 | 1.54E-04 | 3.00E+01            |
| 2. Average Release Rate                            | uci/sec | 2.26E-05 | 1.96E-05 |                     |
| 3. Gross Alpha Radioactivity                       | Ci      | 6.31E-07 | 1.18E-06 |                     |
| <b>D. Tritium</b>                                  |         |          |          |                     |
| 1. Total Release                                   | Ci      | 2.01E+00 | 2.60E+00 | 1.00E+01            |
| 2. Average Release Rate                            | uci/sec | 2.59E-01 | 3.31E-01 |                     |
| <b>E. Percent Qtrly Tech Spec Reporting Levels</b> |         |          |          |                     |
| 1. Iodines, Particulates, and Tritium              | %       | 6.14E-02 | 7.41E-02 |                     |



RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1A Gaseous Effluents - Summation of all Releases

|  | Units   | 3rd Qtr  | 4th Qtr  | Est. Total Error, % |
|--|---------|----------|----------|---------------------|
| <b>A. Fission &amp; Activation gases</b>           |         |          |          |                     |
| 1. Total Release                                   | Ci      | 4.09E+01 | 1.14E+02 | 2.00E+01            |
| 2. Average Release Rate                            | uci/sec | 5.15E+00 | 1.43E+01 |                     |
| 3. Percent Tech Spec Qtrly Reporting Level         |         |          |          |                     |
| Gamma Radiation                                    | %       | 9.21E-03 | 6.06E-02 |                     |
| Beta Radiation                                     | %       | 2.83E-03 | 7.32E-03 |                     |
| <b>B. Iodines</b>                                  |         |          |          |                     |
| 1. Total I-131 Release                             | Ci      | 8.52E-04 | 4.58E-04 | 1.00E+01            |
| 2. Average I-131 Release Rate                      | uci/sec | 1.07E-04 | 5.76E-05 |                     |
| <b>C. Particulates</b>                             |         |          |          |                     |
| 1. Total Particulates                              | Ci      | 1.77E-04 | 6.73E-04 | 3.00E+01            |
| 2. Average Release Rate                            | uci/sec | 2.23E-05 | 8.47E-05 |                     |
| 3. Gross Alpha Radioactivity                       | Ci      | 7.53E-07 | 9.77E-06 |                     |
| <b>D. Tritium</b>                                  |         |          |          |                     |
| 1. Total Release                                   | Ci      | 2.97E+00 | 2.06E+00 | 1.00E+01            |
| 2. Average Release Rate                            | uci/sec | 3.73E-01 | 2.60E-01 |                     |
| <b>E. Percent Qtrly Tech Spec Reporting Levels</b> |         |          |          |                     |
| 1. Iodines, Particulates, and Tritium              | %       | 9.25E-02 | 4.90E-02 |                     |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1B Gaseous Effluents - Elevated Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| KR-87             | Ci   | 2.18E-01        | 5.20E-01 | 0.00E+00   | 0.00E+00 |
| KR-88             | Ci   | 2.39E-02        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| XE-133            | Ci   | 7.37E+00        | 8.33E+00 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 7.38E-01        | 2.16E+00 | 0.00E+00   | 0.00E+00 |
| XE-135M           | Ci   | 2.02E+00        | 4.28E+00 | 0.00E+00   | 0.00E+00 |
| XE-137            | Ci   | 1.07E+01        | 2.77E+01 | 0.00E+00   | 0.00E+00 |
| XE-138            | Ci   | 4.53E+00        | 1.21E+01 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 2.56E+01        | 5.50E+01 | 0.00E+00   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 3.39E-04        | 3.82E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 2.84E-03        | 3.79E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 3.10E-03        | 6.90E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 6.28E-03        | 1.11E-02 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CO-60             | Ci   | 1.26E-06        | 7.24E-07 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 1.50E-06        | 2.38E-07 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 2.69E-05        | 2.74E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 5.40E-06        | 1.09E-05 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 5.00E-08        | 6.92E-08 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 3.51E-05        | 3.93E-05 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1B Gaseous Effluents - Elevated Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 3rd Qtr         | 4th Qtr  | 3rd Qtr    | 4th Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| KR-85M            | Ci   | 0.00E+00        | 6.07E+00 | 0.00E+00   | 0.00E+00 |
| KR-87             | Ci   | 1.77E-01        | 1.45E+01 | 0.00E+00   | 0.00E+00 |
| KR-88             | Ci   | 5.13E-02        | 1.77E+01 | 0.00E+00   | 0.00E+00 |
| XE-133            | Ci   | 1.86E+01        | 9.93E+00 | 0.00E+00   | 0.00E+00 |
| XE-133M           | Ci   | 1.41E-01        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 9.96E-01        | 4.32E+01 | 0.00E+00   | 0.00E+00 |
| XE-135M           | Ci   | 2.90E+00        | 3.16E+00 | 0.00E+00   | 0.00E+00 |
| XE-137            | Ci   | 1.06E+01        | 8.25E+00 | 0.00E+00   | 0.00E+00 |
| XE-138            | Ci   | 6.66E+00        | 9.61E+00 | 0.00E+00   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 5.86E-01 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 4.01E+01        | 1.13E+02 | 0.00E+00   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 5.54E-04        | 2.94E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 4.97E-03        | 1.65E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 8.51E-03        | 2.29E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 1.40E-02        | 4.23E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CR-51             | Ci   | 0.00E+00        | 7.54E-07 | 0.00E+00   | 0.00E+00 |
| MN-54             | Ci   | 0.00E+00        | 3.42E-07 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 5.86E-07        | 4.08E-06 | 0.00E+00   | 0.00E+00 |
| ZN-65             | Ci   | 0.00E+00        | 2.97E-07 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 0.00E+00        | 8.53E-06 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 3.19E-05        | 6.82E-05 | 0.00E+00   | 0.00E+00 |
| CE-141            | Ci   | 1.62E-07        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 1.15E-05        | 4.90E-04 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 9.17E-08        | 4.14E-07 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 4.42E-05        | 5.73E-04 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1C Gaseous Effluents - Building Vent Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| XE-135            | Ci   | 4.19E+00        | 1.66E+00 | 2.82E-03   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 0.00E+00 | 1.06E-02   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 4.19E+00        | 1.66E+00 | 1.34E-02   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 2.02E-04        | 2.36E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 1.16E-03        | 1.80E-03 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 1.37E-03        | 2.04E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| MN-54             | Ci   | 5.04E-06        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 5.80E-05        | 5.85E-05 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 3.10E-05        | 4.94E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 4.39E-05        | 6.46E-06 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 3.08E-06        | 3.72E-08 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 1.41E-04        | 1.14E-04 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 1C Gaseous Effluents - Building Vent Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 3rd Qtr         | 4th Qtr  | 3rd Qtr    | 4th Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| XE-133            | Ci   | 0.00E+00        | 6.62E-01 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 8.08E-01        | 0.00E+00 | 0.00E+00   | 3.23E-03 |
| AR-41             | Ci   | 0.00E+00        | 0.00E+00 | 0.00E+00   | 1.54E-02 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 8.08E-01        | 6.62E-01 | 0.00E+00   | 1.86E-02 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 2.97E-04        | 1.63E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 2.16E-03        | 7.40E-04 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 2.46E-03        | 9.03E-04 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| MN-54             | Ci   | 0.00E+00        | 5.90E-06 | 0.00E+00   | 0.00E+00 |
| CO-57             | Ci   | 4.84E-07        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CO-58             | Ci   | 0.00E+00        | 1.13E-06 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 8.31E-05        | 6.93E-05 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 4.34E-05        | 1.92E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 5.94E-06        | 5.05E-06 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 1.33E-04        | 1.01E-04 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 2A Liquid Effluents - Summation of all Releases

|  | Units  | 1st Qtr  | 2nd Qtr  | Est. Total Error, % |
|--|--------|----------|----------|---------------------|
| A. Fission & Activation products                       |        |          |          |                     |
| 1. Total Release (not including tritium, gases, alpha) | Ci     | 0.00E+00 | 7.60E-07 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 7.17E-11 |                     |
| B. Tritium   |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| C. Dissolved and Entrained Gases                       |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| D. Percent Qtrly Tech Spec Reporting Level             |        |          |          |                     |
| 1. Whole Body Dose                                     | %      | 0.00E+00 | 2.13E-04 |                     |
| 2. Organ Dose  | %      | 0.00E+00 | 9.76E-05 |                     |
| E. Gross Alpha Radioactivity                           |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| F. Volume of Waste Released                            |        |          |          |                     |
|  | Liters | 0.00E+00 | 4.06E+03 | 3.00E+01            |
| F. Volume of Dilution Water Used                       |        |          |          |                     |
|  | Liters | 0.00E+00 | 1.06E+07 | 3.00E+01            |

Table 2B Liquid Effluents

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| Co-60             | Ci   | 0.00E+00        | 1.80E-07 | 0.00E+00   | 0.00E+00 |
| Cs-137            | Ci   | 0.00E+00        | 5.80E-07 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 2A Liquid Effluents - Summation of all Releases

|  | Units  | 3rd Qtr  | 4th Qtr  | Est. Total Error, % |
|--|--------|----------|----------|---------------------|
| A. Fission & Activation products                       |        |          |          |                     |
| 1. Total Release (not including tritium, gases, alpha) | Ci     | 0.00E+00 | 1.06E-07 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 2.59E-08 |                     |
| B. Tritium   |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 4.99E-08 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 1.23E-08 |                     |
| C. Dissolved and Entrained Gases                       |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| D. Percent Qtrly Tech Spec Reporting Level             |        |          |          |                     |
| 1. Whole Body Dose                                     | %      | 0.00E+00 | 1.50E-05 |                     |
| 2. Organ Dose  | %      | 0.00E+00 | 1.09E-05 |                     |
| E. Gross Alpha Radioactivity                           |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| F. Volume of Waste Released                            |        |          |          |                     |
|  | Liters | 0.00E+00 | 4.54E+01 | 3.00E+01            |
| F. Volume of Dilution Water Used                       |        |          |          |                     |
|  | Liters | 0.00E+00 | 4.07E+03 | 3.00E+01            |

Table 2B Liquid Effluents

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 3rd Qtr         | 4th Qtr  | 3rd Qtr    | 4th Qtr  |
| Mn-54             | Ci   | 0.00E+00        | 1.16E-08 | 0.00E+00   | 0.00E+00 |
| Co-58             | Ci   | 0.00E+00        | 4.54E-09 | 0.00E+00   | 0.00E+00 |
| Co-60             | Ci   | 0.00E+00        | 7.67E-08 | 0.00E+00   | 0.00E+00 |
| Zn-65             | Ci   | 0.00E+00        | 1.27E-08 | 0.00E+00   | 0.00E+00 |

RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 3 Solid Waste and Irradiated Fuel Shipments

## A. Solid Waste Shipped Offsite for Burial or Disposal (not irradiated fuel)

| 1. Type of Waste  | Units                 | 12-month Period      | Est. Total Error, % |
|---|-----------------------|----------------------|---------------------|
| A. Spent resins, filter sludges, evaporator bottoms, etc. | Cu. Meter<br>Ci (est) | 1.75E+01<br>1.98E+01 | 3.70E+01            |
| B. Dry compressible waste, contaminated equipment, etc.   | Cu. Meter<br>Ci (est) | 9.92E+01<br>4.17E-01 | 3.50E+01            |
| C. Irradiated components, control rods, etc.              | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| D. Other (describe)                                       | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |

| 2. Estimate of major nuclide composition (by type of waste) |                |                |                |                |
|---|----------------|----------------|----------------|----------------|
| Nuclide   | Type A percent | Type B percent | Type C percent | Type D percent |
| H-3   | 1.40E-01       | 6.62E-02       |                |                |
| C-14  | 6.48E-02       | 6.36E-02       |                |                |
| Cr-51   | 2.54E+00       | 5.23E-02       |                |                |
| Mn-54   | 6.57E+00       | 2.61E+00       |                |                |
| Fe-55   | 3.04E+01       | 6.60E+01       |                |                |
| Co-58   | 6.34E-01       | 2.24E-03       |                |                |
| Fe-59   | 2.05E-01       | 8.45E-02       |                |                |
| Ni-59   | 4.05E-03       | 1.40E-02       |                |                |
| Co-60   | 3.05E+01       | 2.26E+01       |                |                |
| Ni-63   | 8.95E-01       | 7.23E-01       |                |                |
| Zn-65   | 6.88E+00       | 3.44E+00       |                |                |
| Sr-89   | 1.18E-01       |                |                |                |
| Sr-90   | 7.91E-02       | 1.88E-02       |                |                |
| Tc-99   | 3.43E-02       |                |                |                |
| Ag110m  | 7.25E-01       |                |                |                |
| I-131   | 5.78E-01       |                |                |                |
| Cs-134  | 2.14E-02       |                |                |                |
| Cs-137  | 1.93E+01       | 9.84E-01       |                |                |
| Ba-140  | 1.73E-01       | 2.21E-02       |                |                |
| Ce-141  | 1.18E-01       |                |                |                |
| Ce-144  | 5.69E-03       |                |                |                |
| Eu-154  |                | 3.07E+00       |                |                |
| Pu-238  | 9.37E-04       | 5.06E-03       |                |                |
| Pu-239  | 5.39E-04       | 4.04E-03       |                |                |
| Am-241  | 3.04E-03       | 1.19E-02       |                |                |
| Pu-241  | 3.47E-02       | 1.86E-01       |                |                |
| Cm-242  | 8.37E-04       | 1.90E-03       |                |                |
| Cm-243  | 1.59E-03       | 3.57E-03       |                |                |
| Eu-152  |                | 2.71E+00       |                |                |



RADIOACTIVE EFFLUENT RELEASE REPORT  
Period : Jan - Dec 2001

Table 3 Solid Waste and Irradiated Fuel Shipments

## 3. Solid waste disposal

| Number of Shipments | Mode of Transportation | Destination                  |
|---------------------|------------------------|------------------------------|
| 1                   | Truck                  | ATG Inc., Richland, WA.      |
| 3                   | Truck                  | Chem-Nuc Inc., Barnwell, SC. |
| 8                   | Truck                  | Duratek Inc., Oak Ridge, TN. |

## B. Irradiated Fuel Shipments

## 1. Disposition

| Number of Shipments | Mode of Transportation | Destination |
|---------------------|------------------------|-------------|
| None This Period    |                        |             |

## C. Shipping Container and Solidification Method

| No.   | Volume M3 | Activity Ci | Type of Waste | Container Code | Solidification Code |
|-------|-----------|-------------|---------------|----------------|---------------------|
| 0123  | 5.83E+00  | 7.80E+00    | A             | L              | D                   |
| 0125  | 5.83E+00  | 7.17E+00    | A             | L              | D                   |
| 0127  | 5.83E+00  | 4.85E+00    | A             | L              | D                   |
| 0112  | 4.08E+01  | 4.30E-02    | B             | L              | N                   |
| 01-15 | 5.73E+01  | 2.37E-01    | B             | L              | N                   |
| 9917  | 5.59E-03  | 6.98E-03    | B             | L              | N                   |
| 9908  | 5.98E-02  | 4.30E-02    | B             | L              | N                   |
| 9906  | 6.00E-02  | 2.40E-02    | B             | L              | N                   |
| 0035  | 7.70E-02  | 1.24E-03    | B             | L              | N                   |
| 0026  | 4.05E-02  | 4.75E-02    | B             | L              | N                   |
| 0036  | 3.66E-01  | 1.13E-02    | B             | L              | N                   |
| 9838C | 4.30E-01  | 2.96E-03    | B             | L              | N                   |

## Waste type Codes :

A - Spent resins, sludges  
B - Dry waste, equipment  
C - Irradiated components  
D - Other (describe)

## Container Codes :

L - LSA  
A - Type A  
B - Type B  
Q - Large Quantity

## Solidification Codes :

C - Cement  
U - Urea Formaldehyde  
D - Dewatering  
N - Not Applicable

### **Solid Radwaste Effluent Reporting Deviation**

MNGP has reported waste volume and activity *buried* during the report period contrary to the Administrative Controls section of Technical Specifications 6.7.A.4 (Admin Tech Specs) which calls for reporting solid waste *shipped offsite* during the report period. This practice began when MNGP started utilizing offsite vendors for waste processing in 1989.

#### Cause:

MNGP's previous interpretation of solid waste effluent had been that the waste was not effluent until it was finally disposed, that is, incorporated into the environment. This interpretation seems to have originated from a recommendation by a radwaste vendor. Apparently, it was adopted without referring to the requirements of the Admin Tech Specs.

#### Corrective Actions:

- 1) Investigation and determination of the overall magnitude and impact of the error;
- 2) Reporting the results of the investigation to correct for the cumulative effect of the error over time.

#### Actions to Prevent Recurrence:

- 1) We have changed our reporting method so that future reports will reflect the requirements of Administrative Controls;
- 2) We have ensured that all individuals involved in the production of the solid radwaste effluent report are aware of the reporting error, its causes and corrective actions;
- 3) We have ensured that all procedures and documents that govern production of the solid radwaste effluent report agree with Admin Tech Specs.

#### Significance:

MNGP analyzed report and shipment data for each reporting period that could have been affected. Assessment of the impact of the reporting deviation was recorded using the Corrective Action Program (CR 20023318). The old reporting method gave rise to errors in three reporting criteria: activity, volume and destination (of the waste shipment)

Differences in activity arose when the waste is buried in a different reporting period than it was shipped. Over time, the activity differences between reporting methods cancel as waste is buried. The estimated difference between reporting methods is essentially zero (0.0018 percent). Therefore, the impact of deviating from the reporting method called for in the Admin Tech Specs was insignificant.

Differences in volumes reported between the two reporting methods arose because of volume reduction. Overall, we shipped 2686 cubic meters of solid waste from 1989 to present. However, after volume reduction, 933 cubic meters were buried and later reported. The impact of this error to the health and safety of the public was insignificant.

The final difference in reporting criteria between the two methods is in the waste destination. In the old method, the burial site was the destination reported along with the activity and volume as the waste was buried. In the new method, the initial destination will be reported.

Deviation Corrected in this Report:

- 1) Reporting method has been corrected for this and future reports.
- 2) A "true-up" for the cumulative error in volume and activity between the old and new reporting methods is included in this report. It is shown in table 3.C, "Shipping Container and Solidification Method" on page 13 of the report this report. The last 7 entries on table 3.C represent parts of 7 shipments that still remained at waste vendors' sites at the end of 2000. This waste had a total volume of 36.7 cubic feet and total activity of 0.137 curies.

Reporting these seven shipments resolves the underreporting by the old method.

**Attachment B**

Off-Site Radiation Dose Assessment  
for January 1- December 31, 2001

(8 Pages)

# MONTICELLO NUCLEAR GENERATING PLANT

## Offsite Radiation Dose Assessment for January 1, - December 31, 2001

An assessment of radiation dose due to releases from the Monticello Nuclear Generating Plant during 2001 was performed in accordance with the Offsite Dose Calculation Manual (ODCM). Computed doses were well below the 40 CFR 190 Standards and 10 CFR Part 50, Appendix I Guidelines.

Offsite dose calculation formulas and meteorological data from the Offsite Dose Calculation Manual were used in making this assessment. Source terms were obtained from the Radioactive Effluent Release Report for 2001.

### **Offsite Dose from Gaseous Releases** (ODCM -08.01 section 2.1.3)

Computed dose due to gaseous releases are reported in Table 1. Critical receptor location and pathways for organ dose are reported in Table 2. Whole body and organ dose due to gaseous releases are a small percentage of Appendix I Guidelines.

### **Offsite Dose From Liquid Releases** (ODCM -08.01 section 2.1.3)

Dose from liquid releases are listed in Table 1. Dose is based on release of Turbine Building Normal Drain Sump water releases in the second and fourth quarters with H-3, Mn-54, Co-58, Co-60, Zn-65, and Cs-137 activity present. Whole body and organ dose due to liquid releases are a small percentage of Appendix I Guidelines.

### **Dose to Individuals Due to Their Activities Inside the Site Boundary** (ODCM -08.01 section 2.1.3)

Computed dose to the whole body, skin and organ (thyroid), are reported in Table 1. There are several groups of concern, construction work on the cooling towers, sportsmen entering the Monticello site for recreational activities and XCEL Energy Company transmission and distribution crews working in the substation. Use of a very conservative assumption of 40 hours/week spent inside the site boundary by these groups would conservatively represent the most exposed individual. The annual whole body, skin and organ dose was computed using plant stack and reactor building vent X/Q and D/Q values for the number 11 cooling tower location (a bounding location due to predominant wind direction and nearness to the release points) as input to the GASPAR code. This computed dose was reduced by the factor of 40/168 to account for limited occupancy.

**Dose to the Likely Most Exposed Member of the General Public from Reactor Releases and Other Nearby Uranium Fuel Cycle Sources** (ODCM –08.01 section 2.1.4)

There are no other uranium fuel facilities in the vicinity of the Monticello site. The only artificial source of exposure to the general public in addition to the plant effluent releases is from direct radiation of the reactor and the steam turbines.

Environmental TLDs were used to provide data on direct and skyshine radiation dose and the GASPARG code was used to provide data on dose from airborne pathways. The net dose from the TLDs was added to the GASPARG dose data for locations of off site residences and personnel with activities inside the site boundary. This data indicates that the annual whole body and organ dose to each of these locations is less than 16 millirem. (see pages 5 and 6 for details)

Therefore, the likely most exposed member of the general public will not receive an annual radiation dose from reactor effluent releases and all other fuel cycle activities in excess of 40 CFR 190 standards of 25 millirem to the whole body, 75 millirem to the thyroid, and 25 millirem to any other organ.

**Changes in Land Use and Non Obtainable Milk or Vegetable Samples**  
(ODCM –08.01 sections 2.1.8 and 2.1.9)

There were no changes in land use resulting in significant increases in calculated doses. Milk samples were unavailable at sample location M-28 (Hoglund Farm) from 7/25/01 to 12/31/01 due to the farm being temporarily out of business. Land use census results show that there were no other indicator sample locations to replace this farm. Milk production and sampling has resumed at the Hoglund farm starting 1/02/02. There were no vegetable samples that could not be obtained during this reporting period.

**Table 1**

**OffSite Radiation Dose Assessment - Monticello**

**PERIOD: January 1, through December 31, 2001**

| <b>GASEOUS RELEASES</b>   | <b>DOSE</b> | <b>10CFR50 Appendix I Guidelines</b> |
|---|-------------|--------------------------------------|
| Maximum Site Boundary Gamma Air Dose (mrad/year)                                    | 0.003       | 10                                   |
| Maximum Site Boundary Beta Air Dose (mrad/year)                                     | 0.004       | 20                                   |
| Maximum Off-Site Dose to Any Organ (mrem/year)                                      | 0.011       | 15                                   |
| Maximum Dose to the Likely Most Exposed Member of the General Public (mrem/year)    |             |                                      |
| Whole Body  | 0.006       | 5                                    |
| Skin  | 0.007       | 15                                   |
| Organ (Thyroid)   | 0.011       | 15                                   |
| <b>LIQUID RELEASES</b>  |             |                                      |
| Maximum Off-Site Dose (mrem)  |             |                                      |
| Whole Body  | 1.61E-05    | 3                                    |
| Organ   | 1.72E-04    | 10                                   |
| <b>GASEOUS RELEASES</b>   | <b>DOSE</b> | <b>40 CFR 190 LIMITS</b>             |
| Maximum Dose to Individuals due to their Activities Inside the Site Boundary (mrem) |             |                                      |
| Whole Body  | 0.012       | 25                                   |
| Thyroid   | 0.014       | 75                                   |
| Any Other Organ (Skin)  | 0.015       | 25                                   |

**Table 2**

**OffSite Radiation Dose Assessment - Monticello  
Supplemental Information**

**PERIOD: January 1, through December 31, 2001**

| <b>GASEOUS RELEASES</b>  |                                      |                      |
|--|--------------------------------------|----------------------|
| Maximum Site Boundary Dose Location<br>(from Reactor Building Vents) |                                      |                      |
| Sector   | SSE                                  |                      |
| Distance (miles)   | 0.40                                 |                      |
| Number 11 Cooling Tower  |                                      |                      |
| Sector   | NE                                   |                      |
| Distance from Plant Stack (miles)                                    | 0.09                                 |                      |
| Distance from Reactor Building Vents                                 | 0.13                                 |                      |
| Critical Receptor Location   |                                      |                      |
| Sector   | SSW                                  |                      |
| Distance from Reactor Building Vents (miles)                         | 0.60                                 |                      |
| Pathways   | Plume, Ground, Inhalation, Vegetable |                      |
| Age Group  | CHILD                                |                      |
| Organ  | THYROID                              |                      |
| <b>LIQUID RELEASES</b>   |                                      |                      |
| St. Paul Drinking Water Intake Location                              |                                      |                      |
| Pathways   | Drinking Water                       | Drinking Water, Fish |
| Age Group  | Infant                               | Adult                |
| Organ  | Whole Body                           | GI Tract             |
| Dilution Factor (drinking water)                                     | 7:1                                  | 7:1                  |



## Bases for Radiation Dose Statements

### 40 CFR 190 Limits for Annual Dose Equivalent

Whole Body – 25 mrem

Thyroid – 75 mrem

Any Other Organ – 25 mrem

### Critical Receptor Locations

Maximum Organ Dose – 0.6 miles SSW

Maximum Site Boundary TLD – 0.4 miles W

### Maximally Exposed Individuals

#### A. Maximum Offsite Dose from Airborne Effluents (Calculated by GASPAR program)

|                  |            |
|------------------|------------|
| Whole Body:      | 0.012 mrem |
| Thyroid:         | 0.014 mrem |
| Any Other Organ: | 0.015 mrem |

#### B. Dose from Shine

| <u>TLD</u> | <u>Location</u>                 | <u>Mean Reading<br/>(mrem/91 days)</u> | <u>Standard Deviation</u>                   |
|------------|---------------------------------|--|---|
| Controls   | 4 quadrants @<br>90° separation | 14.1                                   | 0.36 (4 sites all >10<br>mile distance)     |
| M-09A      | 0.6 miles SSW                   | 13.6                                   | 0.89 (in direction of<br>Critical Receptor) |
| M-12A      | 0.4 miles W                     | 16.0                                   | 1.18 (maximum site<br>boundary TLD)         |

The difference (D) between the indicator and control TLDs, the standard deviation of D, and the limits for D at the 90% confidence level are as follows:

| <u>TLD</u> | <u>D</u> | <u>Std Dev</u> | <u>90% Conf</u> | <u>Limits at 90% Confidence</u> |
|------------|----------|----------------|-----------------|---------------------------------|
| M-09A      | -0.51    | 0.96           | 1.58            | -2.09 < D < 1.07                |
| M-12A      | 2.25     | 0.41           | 0.67            | -0.13 < D < 3.92                |

M-09A – Because zero is in the interval, there may be no difference between the indicator and control TLDs. At the 90% confidence level, the difference is no greater than 1.07 mrem per 91 days, or approximately 4.3 mrem/year.

M-12A – Because zero is in the interval, there may be no difference between the indicator and control TLDs. At the 90% confidence level, the difference is no greater than 3.92 mrem per 91 days, or approximately 15.7 mrem/year.

C. Maximum Total Dose

Annual Dose from effluents to any individual, regardless of location, will be no more than:

|               |            |
|---------------|------------|
| Whole Body:   | 0.011 mrem |
| Thyroid:      | 0.014 mrem |
| Other Organs: | 0.015 mrem |

Annual Direct Dose will be no more than: 15.7 mrem

Therefore, the maximum dose quantities for comparison to 49 CFR 190 limits are (mrem/year):

|                  | <u>Dose</u> | <u>Limit</u> |
|------------------|-------------|--------------|
| Whole Body:      | 15.71       | 25           |
| Thyroid:         | 15.71       | 75           |
| Any Other Organ: | 15.72       | 25           |

## Bypass of Offgas Storage Building for Greater than Seven Days

The offgas storage system was bypassed 12/14/01 for plant startup following the 2001 refueling outage per plant startup procedures and as allowed in ODCM-03.01, Section 2.4.1.A: "In accordance with T.S.6.8.D.6, the OFF-GAS TREATMENT SYSTEM SHALL be in operation whenever the Main Condenser Air Ejector system is in operation except during Plant Startup or Plant Shutdown."

ODCM-03.01, Section 2.4.3 Action states: "With gaseous waste being discharged for more than seven (7) days with an average holdup time of less than 50 hours, document and report IAW ODCM-01.01, Section 2.4.1.C." The ODCM action statement was entered when the air ejector system was placed in service on 12/14/01.

Following plant startup, post-recombiner offgas flow was at an abnormally high level (approx. 35 SCFM) due to high main condenser air inleakage. At this inleakage rate, the storage system could not meet the ODCM-required average holdup time of 50 hours. On 12/21/01 the seven-day action period was exceeded, which requires documentation per ODCM-01.01, Section 2.4.1.C: "Noncompliance with a CONTROL and associated ACTION, or a Surveillance Requirement SHALL be documented in the annual "Radioactive Effluent Release Report" covering the period of the noncompliance."

An investigation was initiated shortly after plant startup to determine the source of excessive air inleakage. This investigation included identification of possible inleakage pathways and systematic helium leak testing of relevant portions of the plant by both plant personnel and a vendor experienced in inleakage inspections. One inleakage source (packing leak) was found on 12/15/01 while the plant was at low power. Following an exhaustive search in steam areas the plant ascended to full power and the investigation was restricted to radiologically accessible areas, which did not include most of the condenser room and feedwater heater area. When no significant air inleakage was discovered in accessible areas, plant reactor power was reduced to 70% to allow further investigation in the condenser and feedwater heater areas, including retesting of components using helium leak detection and manual checking of possible leaking isolation valves. During this evolution the major inleakage source (leaking valve) was found and corrected on 1/12/02.

Condenser air inleakage then dropped to approximately 10 SCFM. The offgas storage system was placed in service 1/13/02, returning the plant to compliance with the ODCM requirement of greater than 50 hours holdup time.

Cause: The offgas storage system was unable to maintain the required holdup time due to high condenser air inleakage. There were two major sources:

- 1) Low-pressure feedwater heater dump valve packing leak, 5 cfm.
- 2) Low-pressure feedwater heater drain valve, 15 cfm. The valve had been closed hand-tight per plant pre-start valve checklist, and required use of a valve wrench to fully close (an additional handwheel quarter

turn). The drain line for this valve joins a common drain line with numerous inputs. It is presumed that one of these inputs opens to an area inaccessible to inspection and testing, since it was not found during the exhaustive helium leak detection investigation. The drain line inputs are not shown on plant drawings.

Corrective  
Actions:

The condenser inleakage investigation and resulting corrective actions are documented in Condition Report 20018244. Immediate corrective actions consisted of repair of the feedwater heater dump valve packing leak and full closure of the feedwater heater drain valve, eliminating the major sources of condenser air inleakage and allowing return of the offgas storage system to service. Current air inleakage is consistent with historical trends.

A work order was written to repair the feedwater heater drain valve, which prevents recurrence of major inleakage from this source. This work will be performed during the next refueling outage.

Significance:

During the period of storage system bypass, release rates were higher than historical. The Gamma air dose was about 2.5 times higher than for the same period of the year 2000 Gamma air dose. The doses for the fourth quarter 2001 were compared to the doses for the fourth quarter 2000. The Beta and Particulates, Iodines, and Tritium doses for the fourth quarter 2001 were less than the corresponding doses for the fourth quarter 2000. The gamma air dose for the fourth quarter 2001 increased from .05% of the 5 mrad limit to .06% of the 5 mrad limit. The doses for the fourth quarter 2001 were within historical values and did not impose upon the health and safety of the public.

**Attachment C**

Effluent and Waste Disposal Semi-Annual Report  
for January – June 1999

(Updated Table 2A Liquid Effluents – Percent of Qtrly Tech Spec Reporting Level)

(9 Pages)

NORTHERN STATES POWER COMPANY  
MONTICELLO NUCLEAR GENERATING PLANT  
License No. DPR-22

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 1999

Supplemental Information

1. Regulatory Limits - Quarterly levels requiring reporting to  
Nuclear Regulatory Commission

A. Noble Gases :

5 mrad/quarter gamma radiation  
10 mrad/quarter beta radiation

B. Long Lived Iodines, Particulates, and Tritium :

7.5 mrem/quarter dose to any organ

C. Liquid Effluents :

1.5 mrem/quarter dose to the total body  
5.0 mrem/quarter dose to any organ

2. Maximum Permissible Concentrations

A. Noble Gases :

10 CFR Part 20, Appendix B, Table II, Column 1

B. Long Lived Iodines, Particulates, and Tritium :

10 CFR Part 20, Appendix B, Table II, Column 1

C. Liquid Effluents :

10 CFR Part 20, Appendix B, Table II, Column 2  
2.0 E-4 uci/ml for dissolved and entrained gases

3. Average Energy

(Not Applicable)

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 1999

Supplemental Information (continued)

4. Measurements and Approximations of Total Radioactivity

A. Noble Gases :

Continuous gross activity monitors in Reactor Building Vent and Plant Stack exhaust streams. Weekly isotopic analysis of exhaust streams.

B. Iodines in Gaseous Effluent :

Continuous monitoring with charcoal cartridges in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

C. Particulates in Gaseous Effluent :

Continuous monitoring with particulate filters in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

D. Tritium in Gaseous Effluent :

Weekly grab samples from Reactor Building Vent and Plant Stack exhaust streams.

E. Liquid Effluents :

Tank sample analyzed prior to each planned release and continuous monitoring of gross activity during planned release.

5. Batch Releases

A. Liquid :

|  |     |        |
|--|-----|--------|
| 1. Number of Batch Releases                | 0   |        |
| 2. Total Time Period for Batch Releases    | 0.0 | min    |
| 3. Maximum Time Period for a Batch Release | 0.0 | min    |
| 4. Average Time Period for a Batch Release | 0.0 | min    |
| 5. Minimum Time Period for a Batch Release | 0.0 | min    |
| 6. Average River Flow During Release       | 0.0 | cf/sec |

B. Gaseous :

|  |        |     |
|--|--------|-----|
| 1. Number of Batch Releases                | 4      |     |
| 2. Total Time Period for Batch Releases    | 2906.0 | min |
| 3. Maximum Time Period for a Batch Release | 1320.0 | min |
| 4. Average Time Period for a Batch Release | 726.5  | min |
| 5. Minimum Time Period for a Batch Release | 367.0  | min |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 1999

## Supplemental Information (continued)

## 6. Abnormal Releases

## A. Liquid :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

## B. Gaseous :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |



EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 1999

Table 1A Gaseous Effluents - Summation of all Releases

|  | Units   | 1st Qtr  | 2nd Qtr  | Est. Total Error, % |
|--|---------|----------|----------|---------------------|
| <b>A. Fission &amp; Activation gases</b>           |         |          |          |                     |
| 1. Total Release                                   | Ci      | 5.35E+01 | 4.93E+01 | 2.00E+01            |
| 2. Average Release Rate                            | uci/sec | 6.88E+00 | 6.27E+00 |                     |
| 3. Percent Tech Spec Qtrly Reporting Level         |         |          |          |                     |
| Gamma Radiation                                    | %       | 6.75E-02 | 4.03E-02 |                     |
| Beta Radiation                                     | %       | 3.16E-02 | 1.65E-02 |                     |
| <b>B. Iodines</b>                                  |         |          |          |                     |
| 1. Total I-131 Release                             | Ci      | 3.67E-03 | 1.09E-03 | 1.00E+01            |
| 2. Average I-131 Release Rate                      | uci/sec | 4.72E-04 | 1.39E-04 |                     |
| <b>C. Particulates</b>                             |         |          |          |                     |
| 1. Total Particulates                              | Ci      | 5.92E-04 | 5.91E-04 | 3.00E+01            |
| 2. Average Release Rate                            | uci/sec | 7.61E-05 | 7.52E-05 |                     |
| 3. Gross Alpha Radioactivity                       | Ci      | 4.48E-06 | 5.25E-07 |                     |
| <b>D. Tritium</b>                                  |         |          |          |                     |
| 1. Total Release                                   | Ci      | 5.59E+00 | 3.10E+00 | 1.00E+01            |
| 2. Average Release Rate                            | uci/sec | 7.19E-01 | 3.95E-01 |                     |
| <b>E. Percent Qtrly Tech Spec Reporting Levels</b> |         |          |          |                     |
| 1. Iodines, Particulates, and Tritium              | %       | 6.49E-01 | 1.19E-01 |                     |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 1B Gaseous Effluents - Elevated Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| KR-85M            | Ci   | 3.43E-01        | 4.64E-01 | 0.00E+00   | 0.00E+00 |
| KR-87             | Ci   | 6.46E-01        | 8.11E-01 | 0.00E+00   | 0.00E+00 |
| KR-88             | Ci   | 6.48E-01        | 1.08E+00 | 0.00E+00   | 0.00E+00 |
| XE-133            | Ci   | 8.31E+00        | 7.29E+00 | 0.00E+00   | 0.00E+00 |
| XE-133M           | Ci   | 1.43E-01        | 3.16E-02 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 5.55E+00        | 8.53E+00 | 0.00E+00   | 0.00E+00 |
| XE-135M           | Ci   | 3.73E+00        | 3.51E+00 | 0.00E+00   | 0.00E+00 |
| XE-137            | Ci   | 1.57E+01        | 1.24E+01 | 0.00E+00   | 0.00E+00 |
| XE-138            | Ci   | 8.61E+00        | 9.69E+00 | 0.00E+00   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 1.07E+00 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 4.37E+01        | 4.49E+01 | 0.00E+00   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 4.29E-04        | 7.22E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 3.14E-03        | 4.31E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 5.16E-03        | 5.21E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 8.74E-03        | 1.02E-02 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CR-51             | Ci   | 8.26E-07        | 2.17E-05 | 0.00E+00   | 0.00E+00 |
| MN-54             | Ci   | 0.00E+00        | 3.39E-06 | 0.00E+00   | 0.00E+00 |
| CO-58             | Ci   | 0.00E+00        | 1.18E-06 | 0.00E+00   | 0.00E+00 |
| FE-59             | Ci   | 0.00E+00        | 2.68E-06 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 7.14E-07        | 5.81E-06 | 0.00E+00   | 0.00E+00 |
| ZN-65             | Ci   | 0.00E+00        | 1.25E-06 | 0.00E+00   | 0.00E+00 |
| NB-95             | Ci   | 0.00E+00        | 9.63E-08 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 0.00E+00        | 1.54E-06 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 3.80E-05        | 2.76E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 1.75E-05        | 4.22E-05 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 1.24E-07        | 1.27E-06 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 5.72E-05        | 1.09E-04 | 0.00E+00   | 0.00E+00 |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 1C Gaseous Effluents - Building Vent Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| XE-133            | Ci   | 0.00E+00        | 0.00E+00 | 0.00E+00   | 1.08E-02 |
| XE-135            | Ci   | 8.44E+00        | 4.06E+00 | 0.00E+00   | 9.29E-03 |
| XE-135M           | Ci   | 1.37E+00        | 3.06E-01 | 0.00E+00   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 0.00E+00 | 0.00E+00   | 4.80E-03 |
| Total for Period  | Ci   | 9.81E+00        | 4.36E+00 | 0.00E+00   | 2.49E-02 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 3.24E-03        | 3.67E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 3.05E-02        | 2.29E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 4.58E-02        | 2.38E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 7.96E-02        | 5.03E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CR-51             | Ci   | 0.00E+00        | 2.97E-05 | 0.00E+00   | 0.00E+00 |
| MN-54             | Ci   | 1.98E-06        | 8.02E-05 | 0.00E+00   | 0.00E+00 |
| CO-58             | Ci   | 1.54E-06        | 5.55E-05 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 1.00E-04        | 2.01E-04 | 0.00E+00   | 0.00E+00 |
| ZN-65             | Ci   | 9.96E-05        | 2.22E-05 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 2.23E-05        | 8.62E-05 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 2.74E-04        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CE-141            | Ci   | 2.62E-05        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 8.00E-06        | 6.87E-06 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 1.49E-07        | 1.73E-07 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 5.34E-04        | 4.82E-04 | 0.00E+00   | 0.00E+00 |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 2A Liquid Effluents - Summation of all Releases

|  | Units  | 1st Qtr  | 2nd Qtr  | Est. Total Error, % |
|--|--------|----------|----------|---------------------|
| A. Fission & Activation products                       |        |          |          |                     |
| 1. Total Release (not including tritium, gases, alpha) | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| B. Tritium   |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 4.52E-06 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 8.24E-10 |                     |
| C. Dissolved and Entrained Gases                       |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| D. Percent Qtrly Tech Spec Reporting Level             |        |          |          |                     |
| 1. Whole Body Dose                                     | %      | 0.00E+00 | 8.41E-07 |                     |
| 2. Organ Dose  | %      | 0.00E+00 | 2.52E-07 |                     |
| E. Gross Alpha Radioactivity                           |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| F. Volume of Waste Released                            |        |          |          |                     |
|  | Liters | 0.00E+00 | 2.27E+03 | 3.00E+01            |
| F. Volume of Dilution Water Used                       |        |          |          |                     |
|  | Liters | 0.00E+00 | 5.49E+06 | 3.00E+01            |

Table 2B Liquid Effluents

| Nuclides Released         | Unit | Continuous Mode |         | Batch Mode |         |
|---------------------------|------|-----------------|---------|------------|---------|
|                           |      | 1st Qtr         | 2nd Qtr | 1st Qtr    | 2nd Qtr |
| None Released This Period |      |                 |         |            |         |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 3 Solid Waste and Irradiated Fuel Shipments

## A. Solid Waste Shipped Offsite for Burial or Disposal (not irradiated fuel)

| 1. Type of Waste  | Units                 | 6-month Period       | Est. Total Error, % |
|---|-----------------------|----------------------|---------------------|
| a. Spent resins, filter sludges, evaporator bottoms, etc. | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| b. Dry compressible waste, contaminated equipment, etc.   | Cu. Meter<br>Ci (est) | 7.61E+00<br>3.09E-01 | 3.50E+01            |
| c. Irradiated components, control rods, etc.              | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| d. Other (describe)                                       | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |

| 2. Estimate of major nuclide composition (by type of waste) |                |                |                |                |
|---|----------------|----------------|----------------|----------------|
| Nuclide   | Type A percent | Type B percent | Type C percent | Type D percent |
| H-3   |                | 3.04E-01       |                |                |
| C-14  |                | 1.20E-01       |                |                |
| Mn-54   |                | 3.81E+00       |                |                |
| Fe-55   |                | 5.57E+01       |                |                |
| Fe-59   |                | 1.00E-04       |                |                |
| Co-60   |                | 2.79E+01       |                |                |
| Ni-63   |                | 4.46E-01       |                |                |
| Zn-65   |                | 1.01E+01       |                |                |
| Sr-90   |                | 3.96E-02       |                |                |
| Cs-137  |                | 1.42E+00       |                |                |
| Ba-140  |                | 2.17E-05       |                |                |
| Eu-154  |                | 4.29E-05       |                |                |
| Pu-238  |                | 5.31E-03       |                |                |
| Pu-239  |                | 3.55E-03       |                |                |
| Am-241  |                | 9.53E-03       |                |                |
| Pu-241  |                | 1.66E-01       |                |                |
| Cm-242  |                | 1.60E-03       |                |                |
| Cm-243  |                | 3.23E-03       |                |                |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 3 Solid Waste and Irradiated Fuel Shipments

## 3. Solid waste disposal

| Number of Shipments | Mode of Transportation | Destination                  |
|---------------------|------------------------|------------------------------|
| 10                  | Truck                  | Chem-Nuc Inc., Barnwell, SC. |
| 4                   | Truck                  | Envirocare, Clive, UT.       |

## B. Irradiated Fuel Shipments

## 1. Disposition

| Number of Shipments | Mode of Transportation | Destination |
|---------------------|------------------------|-------------|
| None This Period    |                        |             |

## C. Shipping Container and Solidification Method

| No.   | Volume M3 | Activity Ci | Type of Waste | Container Code | Solidification Code |
|-------|-----------|-------------|---------------|----------------|---------------------|
| 9812I | 1.64E-01  | 5.89E-03    | B             | L              | N                   |
| 9836f | 1.58E-01  | 1.90E-01    | B             | L              | N                   |
| 9812j | 5.10E-02  | 1.50E-03    | B             | L              | N                   |
| 9812k | 2.83E-03  | 6.00E-04    | B             | L              | N                   |
| 9836g | 1.75E-02  | 4.00E-03    | B             | L              | N                   |
| 9836h | 2.12E-01  | 8.40E-03    | B             | L              | N                   |
| 9836l | 5.95E-01  | 2.42E-02    | B             | L              | N                   |
| 9812m | 1.13E-01  | 4.10E-03    | B             | L              | N                   |
| 9812n | 2.83E-03  | 1.00E-05    | B             | L              | N                   |
| 9812o | 2.23E-01  | 1.20E-02    | B             | L              | N                   |
| 9731c | 1.81E+00  | 2.93E-02    | B             | L              | N                   |
| 9731d | 4.16E+00  | 1.49E-02    | B             | L              | N                   |
| 9812l | 3.12E-02  | 1.10E-03    | B             | L              | N                   |
| 9838a | 5.95E-02  | 1.34E-02    | B             | L              | N                   |

## Container Codes :

L - LSA  
A - Type A  
B - Type B  
Q - Large Quantity

## Solidification Codes :

C - Cement  
U - Urea Formaldehyde  
D - Dewatering  
N - Not Applicable

**Attachment D**

Effluent and Waste Disposal Semi-Annual Report  
for January – June 2000

(Updated Table 2A Liquid Effluents – Percent of Qtrly Tech Spec Reporting Level)

(10 Pages)

NORTHERN STATES POWER COMPANY  
MONTICELLO NUCLEAR GENERATING PLANT  
License No. DPR-22

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Supplemental Information

1. Regulatory Limits - Quarterly levels requiring reporting to  
Nuclear Regulatory Commission

A. Noble Gases :

5 mrad/quarter gamma radiation  
10 mrad/quarter beta radiation

B. Long Lived Iodines, Particulates, and Tritium :

7.5 mrem/quarter dose to any organ

C. Liquid Effluents :

1.5 mrem/quarter dose to the total body  
5.0 mrem/quarter dose to any organ

2. Maximum Permissible Concentrations

A. Noble Gases :

10 CFR Part 20, Appendix B, Table II, Column 1

B. Long Lived Iodines, Particulates, and Tritium :

10 CFR Part 20, Appendix B, Table II, Column 1

C. Liquid Effluents :

10 CFR Part 20, Appendix B, Table II, Column 2  
2.0 E-4 uci/ml for dissolved and entrained gases

3. Average Energy

(Not Applicable)



EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Supplemental Information (continued)

4. Measurements and Approximations of Total Radioactivity

A. Noble Gases :

Continuous gross activity monitors in Reactor Building Vent and Plant Stack exhaust streams. Weekly isotopic analysis of exhaust streams.

B. Iodines in Gaseous Effluent :

Continuous monitoring with charcoal cartridges in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

C. Particulates in Gaseous Effluent :

Continuous monitoring with particulate filters in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

D. Tritium in Gaseous Effluent :

Weekly grab samples from Reactor Building Vent and Plant Stack exhaust streams.

E. Liquid Effluents :

Tank sample analyzed prior to each planned release and continuous monitoring of gross activity during planned release.

5. Batch Releases

A. Liquid :

|  |     |        |
|--|-----|--------|
| 1. Number of Batch Releases                | 0   |        |
| 2. Total Time Period for Batch Releases    | 0.0 | min    |
| 3. Maximum Time Period for a Batch Release | 0.0 | min    |
| 4. Average Time Period for a Batch Release | 0.0 | min    |
| 5. Minimum Time Period for a Batch Release | 0.0 | min    |
| 6. Average River Flow During Release       | 0.0 | cf/sec |

B. Gaseous :

|  |        |     |
|--|--------|-----|
| 1. Number of Batch Releases                | 2      |     |
| 2. Total Time Period for Batch Releases    | 1308.0 | min |
| 3. Maximum Time Period for a Batch Release | 885.0  | min |
| 4. Average Time Period for a Batch Release | 654.0  | min |
| 5. Minimum Time Period for a Batch Release | 423.0  | min |

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## Supplemental Information (continued)

## 6. Abnormal Releases

## A. Liquid :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

## B. Gaseous :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 1A Gaseous Effluents - Summation of all Releases

|  | Units   | 1st Qtr  | 2nd Qtr  | Est. Total<br>Error, % |
|--|---------|----------|----------|------------------------|
| <b>A. Fission &amp; Activation gases</b>           |         |          |          |                        |
| 1. Total Release                                   | Ci      | 1.93E+01 | 3.41E+01 | 2.00E+01               |
| 2. Average Release Rate                            | uci/sec | 2.49E+00 | 4.34E+00 |                        |
| 3. Percent Tech Spec Qtrly<br>Reporting Level      |         |          |          |                        |
| Gamma Radiation                                    | %       | 6.08E-03 | 2.39E-02 |                        |
| Beta Radiation                                     | %       | 1.47E-03 | 1.04E-02 |                        |
| <b>B. Iodines</b>                                  |         |          |          |                        |
| 1. Total I-131 Release                             | Ci      | 6.58E-04 | 6.51E-04 | 1.00E+01               |
| 2. Average I-131 Release Rate                      | uci/sec | 8.46E-05 | 8.28E-05 |                        |
| <b>C. Particulates</b>                             |         |          |          |                        |
| 1. Total Particulates                              | Ci      | 1.80E-04 | 2.43E-04 | 3.00E+01               |
| 2. Average Release Rate                            | uci/sec | 2.32E-05 | 3.09E-05 |                        |
| 3. Gross Alpha Radioactivity                       | Ci      | 7.37E-07 | 2.42E-07 |                        |
| <b>D. Tritium</b>                                  |         |          |          |                        |
| 1. Total Release                                   | Ci      | 1.58E+00 | 2.51E+00 | 1.00E+01               |
| 2. Average Release Rate                            | uci/sec | 2.03E-01 | 3.19E-01 |                        |
| <b>E. Percent Qtrly Tech Spec Reporting Levels</b> |         |          |          |                        |
| 1. Iodines, Particulates,<br>and Tritium           | %       | 9.48E-02 | 7.56E-02 |                        |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 1B Gaseous Effluents - Elevated Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| KR-87             | Ci   | 2.14E-01        | 3.50E-01 | 0.00E+00   | 0.00E+00 |
| KR-88             | Ci   | 0.00E+00        | 3.06E-02 | 0.00E+00   | 0.00E+00 |
| KR-89             | Ci   | 0.00E+00        | 1.65E+00 | 0.00E+00   | 0.00E+00 |
| XE-133            | Ci   | 6.63E+00        | 7.68E+00 | 0.00E+00   | 0.00E+00 |
| XE-133M           | Ci   | 0.00E+00        | 3.71E-02 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 1.89E+00        | 1.48E+00 | 0.00E+00   | 0.00E+00 |
| XE-135M           | Ci   | 1.79E+00        | 3.21E+00 | 0.00E+00   | 0.00E+00 |
| XE-137            | Ci   | 5.31E+00        | 9.60E+00 | 0.00E+00   | 0.00E+00 |
| XE-138            | Ci   | 3.49E+00        | 7.54E+00 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 1.93E+01        | 3.16E+01 | 0.00E+00   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 1.96E-04        | 4.11E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 9.65E-04        | 3.14E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 1.34E-03        | 5.16E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 2.50E-03        | 8.72E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| MN-54             | Ci   | 9.33E-07        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 3.09E-06        | 1.59E-06 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 8.90E-08        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 1.22E-05        | 2.63E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 4.51E-06        | 1.09E-05 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 6.32E-08        | 4.69E-08 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 2.08E-05        | 3.88E-05 | 0.00E+00   | 0.00E+00 |

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Table 1C Gaseous Effluents - Building Vent Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 1st Qtr         | 2nd Qtr  | 1st Qtr    | 2nd Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| XE-135            | Ci   | 0.00E+00        | 2.52E+00 | 2.60E-03   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 0.00E+00 | 1.14E-02   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 0.00E+00        | 2.52E+00 | 1.40E-02   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 4.62E-04        | 2.40E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 1.11E-03        | 1.60E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 5.15E-04        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 2.09E-03        | 1.84E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| MN-54             | Ci   | 1.50E-05        | 6.15E-06 | 0.00E+00   | 0.00E+00 |
| CO-58             | Ci   | 4.12E-06        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 8.83E-05        | 1.05E-04 | 5.21E-06   | 0.00E+00 |
| ZN-65             | Ci   | 1.16E-05        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 3.34E-05        | 9.00E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 2.02E-06        | 3.04E-06 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 5.19E-09        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
|                   |      |                 |          |            |          |
| Total for Period  | Ci   | 1.54E-04        | 2.04E-04 | 5.21E-06   | 0.00E+00 |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 2000

Table 2A Liquid Effluents - Summation of all Releases

|  | Units  | 1st Qtr  | 2nd Qtr  | Est. Total Error, % |
|--|--------|----------|----------|---------------------|
| A. Fission & Activation products                       |        |          |          |                     |
| 1. Total Release (not including tritium, gases, alpha) | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| B. Tritium   |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 1.67E-05 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 3.82E-10 |                     |
| C. Dissolved and Entrained Gases                       |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| D. Percent Qtrly Tech Spec Reporting Level             |        |          |          |                     |
| 1. Whole Body Dose                                     | %      | 0.00E+00 | 2.61E-08 |                     |
| 2. Organ Dose  | %      | 0.00E+00 | 7.84E-09 |                     |
| E. Gross Alpha Radioactivity                           |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| F. Volume of Waste Released                            |        |          |          |                     |
|  | Liters | 0.00E+00 | 1.67E+04 | 3.00E+01            |
| F. Volume of Dilution Water Used                       |        |          |          |                     |
|  | Liters | 0.00E+00 | 4.37E+07 | 3.00E+01            |

Table 2B Liquid Effluents

| Nuclides Released         | Unit | Continuous Mode |         | Batch Mode |         |
|---------------------------|------|-----------------|---------|------------|---------|
|                           |      | 1st Qtr         | 2nd Qtr | 1st Qtr    | 2nd Qtr |
| None Released This Period |      |                 |         |            |         |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jan - Jun 2000

Table 3 Solid Waste and Irradiated Fuel Shipments

## A. Solid Waste Shipped Offsite for Burial or Disposal (not irradiated fuel)

| 1. Type of Waste  | Units                 | 6-month Period       | Est. Total Error, % |
|---|-----------------------|----------------------|---------------------|
| a. Spent resins, filter sludges, evaporator bottoms, etc. | Cu. Meter<br>Ci (est) | 2.34E+01<br>1.13E+02 | 3.70E+01            |
| b. Dry compressible waste, contaminated equipment, etc.   | Cu. Meter<br>Ci (est) | 1.55E+01<br>1.00E+01 | 3.50E+01            |
| c. Irradiated components, control rods, etc.              | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| d. Other (describe)                                       | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |

| 2. Estimate of major nuclide composition (by type of waste) |                |                |                |                |
|---|----------------|----------------|----------------|----------------|
| Nuclide   | Type A percent | Type B percent | Type C percent | Type D percent |
| H-3   | 2.79E-01       | 2.84E-02       |                |                |
| C-14  | 2.30E-01       | 4.62E-02       |                |                |
| Cr-51   | 7.69E-01       | 6.70E-01       |                |                |
| Mn-54   | 4.81E+00       | 2.40E+00       |                |                |
| Fe-55   | 4.16E+01       | 6.76E+01       |                |                |
| Co-57   |                | 8.64E-03       |                |                |
| Co-58   | 8.71E-01       | 2.65E-01       |                |                |
| Fe-59   | 2.94E-01       | 2.61E-01       |                |                |
| Ni-59   | 7.86E-03       | 1.85E-02       |                |                |
| Co-60   | 2.53E+01       | 2.28E+01       |                |                |
| Ni-63   | 6.28E-01       | 8.32E-01       |                |                |
| Zn-65   | 9.19E+00       | 3.21E+00       |                |                |
| Sr-89   |                | 1.42E-03       |                |                |
| Sr-90   | 7.29E-02       | 1.97E-02       |                |                |
| Nb-95   |                | 4.57E-02       |                |                |
| Zr-95   |                | 1.09E-01       |                |                |
| Cd-109  | 1.80E-01       |                |                |                |
| Ag110m  |                | 2.37E-02       |                |                |
| Sb-124  |                | 4.74E-02       |                |                |
| Sb-125  |                | 1.16E-01       |                |                |
| I-131   |                | 6.66E-03       |                |                |
| Cs-134  |                | 1.83E-02       |                |                |
| Cs-137  | 1.57E+01       | 9.89E-01       |                |                |
| Ba-140  | 1.78E-05       | 1.94E-03       |                |                |
| Ce-141  |                | 3.07E-02       |                |                |
| Ce-144  | 7.85E-03       | 5.52E-02       |                |                |
| Eu-154  |                | 7.35E-04       |                |                |
| Pu-238  | 1.00E-03       | 7.73E-03       |                |                |
| Pu-239  | 5.16E-04       | 4.79E-03       |                |                |
| Am-241  | 3.10E-03       | 1.35E-02       |                |                |
| Pu-241  | 3.58E-02       | 1.95E-01       |                |                |
| Cm-242  | 2.40E-03       | 2.49E-03       |                |                |
| Pu-242  |                | 2.73E-03       |                |                |
| Cm-243  | 1.61E-03       | 2.21E-03       |                |                |
| Eu-152  |                | 5.72E-03       |                |                |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 3 Solid Waste and Irradiated Fuel Shipments

## 3. Solid waste disposal

| Number of Shipments | Mode of Transportation | Destination                  |
|---------------------|------------------------|------------------------------|
| 9                   | Truck                  | Chem-Nuc Inc., Barnwell, SC. |
| 30                  | Truck                  | Envirocare, Clive, UT.       |

## B. Irradiated Fuel Shipments

## 1. Disposition

| Number of Shipments | Mode of Transportation | Destination |
|---------------------|------------------------|-------------|
| None This Period    |                        |             |

## C. Shipping Container and Solidification Method

| No.   | Volume M3 | Activity Ci | Type of Waste | Container Code | Solidification Code |
|-------|-----------|-------------|---------------|----------------|---------------------|
| 9917D | 3.17E-01  | 1.10E-03    | B             | A              | N                   |
| 9917E | 2.27E-01  | 7.00E-04    | B             | A              | N                   |
| 9908D | 2.27E-01  | 1.39E-02    | B             | A              | N                   |
| 9908E | 6.12E-01  | 3.11E-02    | B             | A              | N                   |
| 0026B | 6.34E-02  | 1.40E-02    | B             | A              | N                   |
| 0026C | 1.53E-01  | 2.40E-03    | B             | A              | N                   |
| 0026D | 6.23E-02  | 5.60E-03    | B             | A              | N                   |
| 0026E | 5.61E-02  | 5.60E-03    | B             | A              | N                   |
| 0035C | 4.76E-01  | 5.00E-02    | B             | A              | N                   |
| 0035D | 7.70E-01  | 8.30E-02    | B             | A              | N                   |
| 0035E | 1.41E-01  | 9.60E-02    | B             | A              | N                   |
| 0035F | 1.36E-01  | 1.50E-02    | B             | A              | N                   |
| 0035G | 1.70E-01  | 2.80E-02    | B             | A              | N                   |
| 0035H | 1.97E-01  | 2.49E-01    | B             | A              | N                   |
| 0036A | 2.04E-01  | 9.60E-03    | B             | A              | N                   |
| 0036B | 1.59E+00  | 5.30E-02    | B             | A              | N                   |
| 0036C | 2.72E-01  | 7.60E-03    | B             | A              | N                   |
| 0036D | 1.59E-01  | 5.60E-03    | B             | A              | N                   |
| 0036E | 3.17E-01  | 1.30E-02    | B             | A              | N                   |
| 0036F | 2.79E-01  | 1.43E-01    | B             | A              | N                   |
| 0035A | 9.71E-01  | 6.90E-02    | B             | A              | N                   |
| 0035B | 2.27E-01  | 2.03E-02    | B             | A              | N                   |
| 9917F | 4.64E-02  | 3.10E-03    | B             | A              | N                   |
| 00-38 | 5.83E+00  | 4.45E+01    | A             | L              | D                   |
| 00-40 | 5.83E+00  | 2.01E+01    | A             | L              | D                   |
| 00-44 | 5.83E+00  | 8.45E+00    | A             | L              | D                   |
| 00-46 | 5.69E+00  | 8.79E+00    | B             | L              | N                   |
| 00-43 | 5.83E+00  | 1.14E+01    | A             | L              | D                   |



EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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## C. Shipping Container and Solidification Method (Cont.)

| No.   | Volume<br>M3 | Activity<br>Ci | Type of<br>Waste | Container<br>Code | Solidification<br>Code |
|-------|--------------|----------------|------------------|-------------------|------------------------|
| 9908F | 4.70E-02     | 2.00E-04       | B                | A                 | N                      |
| 0026A | 5.66E-01     | 7.00E-03       | B                | A                 | N                      |
| 99-23 | 5.30E-02     | 1.61E+01       | A                | A                 | N                      |
| 0026F | 9.20E-02     | 4.00E-03       | B                | A                 | N                      |
| 0036G | 3.77E-01     | 1.13E-02       | B                | A                 | N                      |
| 9906C | 2.16E-01     | 2.00E-03       | B                | A                 | N                      |
| 9906D | 1.36E-01     | 1.40E-03       | B                | A                 | N                      |
| 9535D | 6.82E-01     | 2.27E-01       | B                | A                 | N                      |
| 9535E | 1.98E-02     | 4.64E-02       | B                | A                 | N                      |
| 9928A | 1.10E-02     | 3.98E+00       | A                | A                 | N                      |
| 9928B | 1.67E-02     | 8.44E+00       | A                | A                 | N                      |

## Container Codes :

L - LSA  
A - Type A  
B - Type B  
Q - Large Quantity

## Solidification Codes :

C - Cement  
U - Urea Formaldehyde  
D - Dewatering  
N - Not Applicable

**Attachment E**

Effluent and Waste Disposal Semi-Annual Report  
for July – December 2000

(Updated Table 2A Liquid Effluents – Percent of Qtrly Tech Spec Reporting Level)

(10 Pages)

NORTHERN STATES POWER COMPANY  
MONTICELLO NUCLEAR GENERATING PLANT  
License No. DPR-22

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jul - Dec 2000

Supplemental Information

1. Regulatory Limits - Quarterly levels requiring reporting to  
Nuclear Regulatory Commission

A. Noble Gases :

5 mrad/quarter gamma radiation  
10 mrad/quarter beta radiation

B. Long Lived Iodines, Particulates, and Tritium :

7.5 mrem/quarter dose to any organ

C. Liquid Effluents :

1.5 mrem/quarter dose to the total body  
5.0 mrem/quarter dose to any organ

2. Maximum Permissible Concentrations

A. Noble Gases :

10 CFR Part 20, Appendix B, Table II, Column 1

B. Long Lived Iodines, Particulates, and Tritium :

10 CFR Part 20, Appendix B, Table II, Column 1

C. Liquid Effluents :

10 CFR Part 20, Appendix B, Table II, Column 2  
2.0 E-4 uci/ml for dissolved and entrained gases

3. Average Energy

(Not Applicable)

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Supplemental Information (continued)

4. Measurements and Approximations of Total Radioactivity

A. Noble Gases :

Continuous gross activity monitors in Reactor Building Vent and Plant Stack exhaust streams. Weekly isotopic analysis of exhaust streams.

B. Iodines in Gaseous Effluent :

Continuous monitoring with charcoal cartridges in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

C. Particulates in Gaseous Effluent :

Continuous monitoring with particulate filters in Reactor Building Vent and Plant Stack exhaust streams with weekly analysis.

D. Tritium in Gaseous Effluent :

Weekly grab samples from Reactor Building Vent and Plant Stack exhaust streams.

E. Liquid Effluents :

Tank sample analyzed prior to each planned release and continuous monitoring of gross activity during planned release.

5. Batch Releases

A. Liquid :

|  |     |        |
|--|-----|--------|
| 1. Number of Batch Releases                | 0   |        |
| 2. Total Time Period for Batch Releases    | 0.0 | min    |
| 3. Maximum Time Period for a Batch Release | 0.0 | min    |
| 4. Average Time Period for a Batch Release | 0.0 | min    |
| 5. Minimum Time Period for a Batch Release | 0.0 | min    |
| 6. Average River Flow During Release       | 0.0 | cf/sec |

B. Gaseous :

|  |        |     |
|--|--------|-----|
| 1. Number of Batch Releases                | 2      |     |
| 2. Total Time Period for Batch Releases    | 1397.0 | min |
| 3. Maximum Time Period for a Batch Release | 982.0  | min |
| 4. Average Time Period for a Batch Release | 698.5  | min |
| 5. Minimum Time Period for a Batch Release | 415.0  | min |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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## Supplemental Information (continued)

## 6. Abnormal Releases

## A. Liquid :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

## B. Gaseous :

|                            |     |    |
|----------------------------|-----|----|
| 1. Number of Releases      | 0   |    |
| 2. Total Activity Released | 0.0 | Ci |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jul - Dec 2000

Table 1A Gaseous Effluents - Summation of all Releases

|  | Units | 3rd Qtr | 4th Qtr | Est. Total Error, % |
|--|-------|---------|---------|---------------------|
|--|-------|---------|---------|---------------------|

## A. Fission &amp; Activation gases

|  |         |          |          |          |
|--|---------|----------|----------|----------|
| 1. Total Release                           | Ci      | 4.72E+01 | 4.98E+01 | 2.00E+01 |
| 2. Average Release Rate                    | uci/sec | 5.94E+00 | 6.26E+00 |          |
| 3. Percent Tech Spec Qtrly Reporting Level |         |          |          |          |
| Gamma Radiation                            | %       | 2.30E-02 | 5.37E-02 |          |
| Beta Radiation                             | %       | 9.21E-03 | 2.95E-02 |          |

## B. Iodines

|                               |         |          |          |          |
|-------------------------------|---------|----------|----------|----------|
| 1. Total I-131 Release        | Ci      | 8.20E-04 | 5.72E-04 | 1.00E+01 |
| 2. Average I-131 Release Rate | uci/sec | 1.03E-04 | 7.19E-05 |          |

## C. Particulates

|                              |         |          |          |          |
|------------------------------|---------|----------|----------|----------|
| 1. Total Particulates        | Ci      | 2.85E-04 | 1.29E-04 | 3.00E+01 |
| 2. Average Release Rate      | uci/sec | 3.59E-05 | 1.63E-05 |          |
| 3. Gross Alpha Radioactivity | Ci      | 8.32E-07 | 5.30E-07 |          |

## D. Tritium

|                         |         |          |          |          |
|-------------------------|---------|----------|----------|----------|
| 1. Total Release        | Ci      | 2.58E+00 | 2.83E+00 | 1.00E+01 |
| 2. Average Release Rate | uci/sec | 3.24E-01 | 3.56E-01 |          |

## E. Percent Qtrly Tech Spec Reporting Levels

|                                       |   |          |          |  |
|---------------------------------------|---|----------|----------|--|
| 1. Iodines, Particulates, and Tritium | % | 8.39E-02 | 6.73E-02 |  |
|---------------------------------------|---|----------|----------|--|

EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT  
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Table 1B Gaseous Effluents - Elevated Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 3rd Qtr         | 4th Qtr  | 3rd Qtr    | 4th Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| KR-87             | Ci   | 5.75E-01        | 3.05E-01 | 0.00E+00   | 0.00E+00 |
| KR-88             | Ci   | 1.09E-01        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| XE-133            | Ci   | 1.38E+01        | 9.24E+00 | 0.00E+00   | 0.00E+00 |
| XE-133M           | Ci   | 1.24E-01        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| XE-135            | Ci   | 1.92E+00        | 1.96E+00 | 0.00E+00   | 0.00E+00 |
| XE-135M           | Ci   | 4.32E+00        | 5.43E+00 | 0.00E+00   | 0.00E+00 |
| XE-137            | Ci   | 1.47E+01        | 1.56E+01 | 0.00E+00   | 0.00E+00 |
| XE-138            | Ci   | 9.80E+00        | 9.00E+00 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 4.54E+01        | 4.16E+01 | 0.00E+00   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 6.00E-04        | 3.09E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 5.51E-03        | 2.54E-03 | 0.00E+00   | 0.00E+00 |
| I-135             | Ci   | 8.42E-03        | 4.43E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 1.45E-02        | 7.28E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CO-60             | Ci   | 2.28E-06        | 6.00E-07 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 1.25E-06        | 1.16E-07 | 0.00E+00   | 0.00E+00 |
| BA-140            | Ci   | 3.02E-05        | 3.10E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 6.20E-06        | 1.25E-05 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 9.10E-08        | 9.75E-08 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 4.00E-05        | 4.44E-05 | 0.00E+00   | 0.00E+00 |

EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT  
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Table 1C Gaseous Effluents - Building Vent Releases

| Nuclides Released | Unit | Continuous Mode |          | Batch Mode |          |
|-------------------|------|-----------------|----------|------------|----------|
|                   |      | 3rd Qtr         | 4th Qtr  | 3rd Qtr    | 4th Qtr  |
| 1. Fission Gases  |      |                 |          |            |          |
| XE-135            | Ci   | 1.81E+00        | 8.21E+00 | 9.82E-04   | 0.00E+00 |
| AR-41             | Ci   | 0.00E+00        | 0.00E+00 | 6.59E-03   | 0.00E+00 |
| Total for Period  | Ci   | 1.81E+00        | 8.21E+00 | 7.57E-03   | 0.00E+00 |
| 2. Iodines        |      |                 |          |            |          |
| I-131             | Ci   | 2.20E-04        | 2.63E-04 | 0.00E+00   | 0.00E+00 |
| I-133             | Ci   | 1.61E-03        | 1.92E-03 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 1.83E-03        | 2.19E-03 | 0.00E+00   | 0.00E+00 |
| 3. Particulates   |      |                 |          |            |          |
| CR-51             | Ci   | 1.04E-05        | 0.00E+00 | 0.00E+00   | 0.00E+00 |
| CO-60             | Ci   | 1.18E-04        | 4.86E-05 | 0.00E+00   | 0.00E+00 |
| CS-137            | Ci   | 1.16E-04        | 3.49E-05 | 0.00E+00   | 0.00E+00 |
| SR-89             | Ci   | 7.20E-07        | 1.56E-06 | 0.00E+00   | 0.00E+00 |
| SR-90             | Ci   | 6.80E-08        | 1.53E-09 | 0.00E+00   | 0.00E+00 |
| Total for Period  | Ci   | 2.45E-04        | 8.50E-05 | 0.00E+00   | 0.00E+00 |



EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
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Table 2A Liquid Effluents - Summation of all Releases

|  | Units  | 3rd Qtr  | 4th Qtr  | Est. Total Error, % |
|--|--------|----------|----------|---------------------|
| A. Fission & Activation products                       |        |          |          |                     |
| 1. Total Release (not including tritium, gases, alpha) | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| B. Tritium   |        |          |          |                     |
| 1. Total Release                                       | Ci     | 2.74E-04 | 0.00E+00 | 3.00E+01            |
| 2. Avg Diluted Concentration                           | uci/ml | 1.44E-09 | 0.00E+00 |                     |
| C. Dissolved and Entrained Gases                       |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| 2. Avg Diluted Concentration                           | uci/ml | 0.00E+00 | 0.00E+00 |                     |
| D. Percent Qtrly Tech Spec Reporting Level             |        |          |          |                     |
| 1. Whole Body Dose                                     | %      | 4.52E-07 | 0.00E+00 |                     |
| 2. Organ Dose  | %      | 1.36E-07 | 0.00E+00 |                     |
| E. Gross Alpha Radioactivity                           |        |          |          |                     |
| 1. Total Release                                       | Ci     | 0.00E+00 | 0.00E+00 | 0.00E+00            |
| F. Volume of Waste Released                            |        |          |          |                     |
|  | Liters | 7.88E+04 | 0.00E+00 | 3.00E+01            |
| F. Volume of Dilution Water Used                       |        |          |          |                     |
|  | Liters | 2.02E+08 | 0.00E+00 | 3.00E+01            |

Table 2B Liquid Effluents

| Nuclides Released         | Unit | Continuous Mode |         | Batch Mode |         |
|---------------------------|------|-----------------|---------|------------|---------|
|                           |      | 3rd Qtr         | 4th Qtr | 3rd Qtr    | 4th Qtr |
| None Released This Period |      |                 |         |            |         |

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT  
Period : Jul - Dec 2000

Table 3 Solid Waste and Irradiated Fuel Shipments

## A. Solid Waste Shipped Offsite for Burial or Disposal (not irradiated fuel)

| 1. Type of Waste  | Units                 | 6-month Period       | Est. Total Error, % |
|---|-----------------------|----------------------|---------------------|
| a. Spent resins, filter sludges, evaporator bottoms, etc. | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| b. Dry compressible waste, contaminated equipment, etc.   | Cu. Meter<br>Ci (est) | 1.88E+01<br>2.24E-01 | 3.50E+01            |
| c. Irradiated components, control rods, etc.              | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |
| d. Other (describe)                                       | Cu. Meter<br>Ci       | 0.00E+00<br>0.00E+00 | 0.00E+00            |

| 2. Estimate of major nuclide composition (by type of waste) |                |                |                |                |
|---|----------------|----------------|----------------|----------------|
| Nuclide   | Type A percent | Type B percent | Type C percent | Type D percent |
| H-3   |                | 1.05E-01       |                |                |
| C-14  |                | 1.24E-01       |                |                |
| Cr-51   |                | 3.77E-01       |                |                |
| Mn-54   |                | 4.17E+00       |                |                |
| Fe-55   |                | 6.36E+01       |                |                |
| Co-58   |                | 5.95E-03       |                |                |
| Fe-59   |                | 7.08E-02       |                |                |
| Ni-59   |                | 2.84E-04       |                |                |
| Co-60   |                | 2.03E+01       |                |                |
| Ni-63   |                | 4.63E-01       |                |                |
| Zn-65   |                | 6.80E+00       |                |                |
| Sr-90   |                | 1.45E-02       |                |                |
| I-131   |                | 9.94E-02       |                |                |
| Cs-137  |                | 1.16E+00       |                |                |
| Ba-140  |                | 7.80E-02       |                |                |
| Eu-154  |                | 2.57E+00       |                |                |
| Pu-238  |                | 2.87E-03       |                |                |
| Pu-239  |                | 1.94E-03       |                |                |
| Am-241  |                | 6.74E-03       |                |                |
| Pu-241  |                | 1.19E-01       |                |                |
| Cm-242  |                | 2.00E-03       |                |                |
| Cm-243  |                | 1.94E-03       |                |                |
| Eu-152  |                | 2.27E+00       |                |                |

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Table 3 Solid Waste and Irradiated Fuel Shipments

## 3. Solid waste disposal

| Number of Shipments | Mode of Transportation | Destination            |
|---------------------|------------------------|------------------------|
| 34                  | Truck                  | Envirocare, Clive, UT. |

## B. Irradiated Fuel Shipments

## 1. Disposition

| Number of Shipments | Mode of Transportation | Destination |
|---------------------|------------------------|-------------|
| None This Period    |                        |             |

## C. Shipping Container and Solidification Method

| No.   | Volume M3 | Activity Ci | Type of Waste | Container Code | Solidification Code |
|-------|-----------|-------------|---------------|----------------|---------------------|
| 9838B | 2.18E-01  | 2.96E-04    | B             | L              | N                   |
| 0026G | 4.53E-01  | 2.30E-03    | B             | L              | N                   |
| 0026H | 9.06E-02  | 7.00E-04    | B             | L              | N                   |
| 0026I | 2.72E-01  | 7.00E-04    | B             | L              | N                   |
| 0026J | 2.95E-01  | 4.00E-04    | B             | L              | N                   |
| 0026K | 2.23E+00  | 1.01E-01    | B             | L              | N                   |
| 0026L | 1.59E-01  | 3.20E-02    | B             | L              | N                   |
| 9917G | 6.25E-02  | 5.00E-04    | B             | L              | N                   |
| 9917H | 4.81E-02  | 4.00E-04    | B             | L              | N                   |
| 9906E | 1.71E-02  | 9.00E-05    | B             | L              | N                   |
| 9906F | 1.13E-01  | 5.00E-04    | B             | L              | N                   |
| 9908G | 3.19E-02  | 2.16E-04    | B             | L              | N                   |
| 9908H | 4.65E-02  | 9.44E-04    | B             | L              | N                   |
| 9908I | 5.31E-02  | 1.70E-03    | B             | L              | N                   |
| 9908J | 7.30E-02  | 3.00E-03    | B             | L              | N                   |
| 9908K | 3.83E-02  | 2.42E-04    | B             | L              | N                   |
| 9908L | 3.64E-01  | 6.28E-03    | B             | L              | N                   |
| 0026M | 2.04E-01  | 2.59E-04    | B             | L              | N                   |
| 0026N | 8.61E-01  | 1.21E-03    | B             | L              | N                   |
| 0026O | 1.59E-01  | 1.89E-04    | B             | L              | N                   |
| 9906G | 3.85E-02  | 2.36E-04    | B             | L              | N                   |
| 9908M | 2.27E-01  | 1.16E-04    | B             | L              | N                   |
| 9906H | 1.13E-01  | 4.93E-04    | B             | L              | N                   |
| 0036H | 6.71E-03  | 1.42E-02    | B             | L              | N                   |
| 0026P | 3.62E-01  | 9.23E-04    | B             | L              | N                   |
| 0036I | 4.93E-02  | 2.98E-03    | B             | L              | N                   |
| 9906I | 6.54E+00  | 2.89E-02    | B             | L              | N                   |
| 9908N | 1.79E-02  | 3.30E-05    | B             | L              | N                   |

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## C. Shipping Container and Solidification Method (Cont.)

| No.   | Volume<br>M3 | Activity<br>Ci | Type of<br>Waste | Container<br>Code | Solidification<br>Code |
|-------|--------------|----------------|------------------|-------------------|------------------------|
| 9917I | 1.40E-02     | 5.38E-05       | B                | L                 | N                      |
| 0036J | 7.82E-01     | 1.15E-02       | B                | L                 | N                      |
| 9917J | 8.27E-01     | 2.99E-03       | B                | L                 | N                      |
| 9917K | 2.61E+00     | 4.62E-03       | B                | L                 | N                      |
| 9917L | 5.08E-01     | 1.29E-03       | B                | L                 | N                      |
| 9908O | 8.71E-01     | 2.60E-03       | B                | L                 | N                      |

## Container Codes :

L - LSA  
A - Type A  
B - Type B  
Q - Large Quantity

## Solidification Codes :

C - Cement  
U - Urea Formaldehyde  
D - Dewatering  
N - Not Applicable

## **Attachment F**

### **Offsite Dose Calculation Manual (ODCM)**

(The Radiological Effluent Technical Specifications were relocated to the ODCM during 2001 by Amendment 120 - 7/24/01)

|  |  |             |
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| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |  | ODCM-INDEX  |
| <b>TITLE:</b>                              | <b>OFFSITE DOSE CALCULATION MANUAL</b> | Revision 3  |
|  | <b>INDEX</b>                           | Page 1 of 1 |

|                                   |                     |                                |                      |
|-----------------------------------|---------------------|--------------------------------|----------------------|
| <b>REVIEW AND APPROVALS</b>       |                     |                                |                      |
| Prepared By: <i>George Shultz</i> |                     |                                |                      |
| Approved By: <i>Carol Stebb</i>   |                     | Effective Date: <i>8/23/01</i> |                      |
| Resp Supv: CHEM                   | Assoc Ref: CHEM MAN | CSR: N                         | Freq: 9 yrs          |
| ARMS: ODCM-INDEX                  | Doc Type: 7030      | Admin Initials: <i>CS</i>      | Date: <i>8/23/01</i> |

| <u>SECTION</u> | <u>TITLE</u>  |
|----------------|---|
| ODCM           | History   |
| ODCM-01.01     | Introduction  |
| ODCM-02.01     | Liquid Effluents  |
| ODCM-03.01     | Gaseous Effluents   |
| ODCM-04.01     | Liquid Effluent Calculations  |
| ODCM-05.01     | Gaseous Effluent Calculations   |
| ODCM-06.01     | Dose From All Uranium Fuel Cycle Sources  |
| ODCM-07.01     | Radiological Environmental Monitoring Program   |
| ODCM-08.01     | Reporting Requirements  |
| ODCM-09.01     | Summary of EBARR Computer Program - Deleted   |
| ODCM-10.01     | Methodology for Computation of Dose Parameters for Radioiodines, Particulates and Tritium - Deleted |
| ODCM-11.01     | Midas Program Descriptions - Deleted  |
| ODCM-APP-A     | Appendix A  |
| ODCM-APP-B     | Appendix B  |
| ODCM-APP-C     | Appendix C  |
| ODCM-12.01     | ODCM-01.01 Figures - Deleted; Incorporated into ODCM-01.01  |
| ODCM-12.02     | ODCM-02.01 Figures - Deleted; Incorporated into ODCM-02.01  |
| ODCM-12.03     | ODCM-03.01 Figures - Deleted; Incorporated into ODCM-03.01  |
| ODCM-12.05     | ODCM-05.01 Figures - Deleted; Incorporated into ODCM-05.01  |
| ODCM-12.09     | ODCM-09.01 Figures - Deleted  |
| ODCM-12.11     | ODCM-12.01 Figures - Deleted  |
| ODCM-13.01     | ODCM-01.01 Tables - Deleted; Incorporated into ODCM-01.01   |
| ODCM-13.02     | ODCM-02.01 Tables - Deleted; Incorporated into ODCM-02.01   |
| ODCM-13.03     | ODCM-03.01 Tables - Deleted; Incorporated into ODCM-03.01   |
| ODCM-13.04     | ODCM-04.01 Tables - Deleted; Incorporated into ODCM-04.01   |
| ODCM-13.05     | ODCM-05.01 Tables - Deleted; Incorporated into ODCM-05.01   |
| ODCM-13.06     | ODCM-06.01 Tables - Deleted; Incorporated into ODCM-06.01   |
| ODCM-13.07     | ODCM-07.01 Tables - Deleted; Incorporated into ODCM-07.01   |
| ODCM-13.08     | ODCM-08.01 Tables - Deleted; Incorporated into ODCM-08.01   |
| ODCM-13.09     | ODCM-09.01 Tables - Deleted   |
| ODCM-13.10     | ODCM-10.01 Tables - Deleted   |
| ODCM-13.11     | ODCM-11.01 Tables - Deleted   |

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| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                       | <b>ODCM-HISTORY</b> |
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RECORD OF REVISION

| <u>Revision No.</u> | <u>Date</u>       | <u>Reason for Revision</u>  |
|---------------------|-------------------|---|
| 0                   | May 2, 1979       | Original.   |
| 1                   | February 29, 1980 | Incorporation of NRC Staff comments and correction of miscellaneous errors.   |
| 2                   | July 23, 1982     | Incorporation of NRC Staff comments, addition of short term vent dispersion parameters, and addition of Appendices D and E.   |
| 3                   | March 24, 1983    | Change in milk sampling location.   |
| 4                   | December 12, 1983 | Change in milk sampling locations and remove formula for converting $\mu\text{Ci}/\text{sec}$ to $\text{mrad}/\text{hr}$ for stack and vent wide range gas monitors.      |
| 5                   | March 27, 1984    | Change Table 3.2-1  |
| 6                   | January - 1988    | Incorporation of MIDAS and complete retyping.   |
| 7                   | January - 1990    | Incorporation of NRC staff comments, correction of miscellaneous errors, clarification of term abnormal release and addition of references to MNGP ODCM computer program. |
| 0                   | November - 1993   | Complete rewrite of ODCM creating modular format allowing changes of a section rather than the whole document.  |

"Record of Revision" is now incorporated into each individual procedure.

|  |                   |
|--|-------------------|
| Prepared By: <i>CB Peterson</i>  |                   |
| Reviewed By: <i>[Signature]</i>  |                   |
| OC Final Review Meeting: # 2242  | Date: 11/02/2000  |
| Approved By Plant Manager: <i>[Signature]</i>                            | Date: 8/21/01     |
| <b>FOR ADMINISTRATIVE USE ONLY</b>                                       |                   |
| 3087 (DOCUMENT CHANGE, HOLD, AND COMMENT FORM) incorporated: <i>None</i> |                   |
| Resp Supv: CHEM  | Assoc Ref: CHEM-I |
| ARMS: ODCM-HISTORY   | Doc Type: 7030    |
| Admin Initials: <i>[Signature]</i>                                       | SR: N             |
|  | Freq: 2 yrs       |
|  | Date: 8/23/01     |

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| 2.1 ODCM Description and Control .....                                | 3           |
| 2.2 Licensee Initiated Changes to the ODCM .....                      | 4           |
| 2.3 Definitions .....   | 5           |
| 2.4 Radiological Effluent Controls And Surveillance Requirement ..... | 9           |

|   |                  |
|---|------------------|
| Prepared By: <i>J. Peterson</i>               |                  |
| Reviewed By: <i>[Signature]</i>               |                  |
| OC Final Review Meeting: # 2242               | Date: 11/02/2000 |
| Approved By Plant Manager: <i>[Signature]</i> | Date: 8/21/01    |

\*This is a major rewrite, therefore, no sidelines are required.

| FOR ADMINISTRATIVE USE ONLY                                  |                   |                                    |               |
|--|-------------------|------------------------------------|---------------|
| 3087 (DOCUMENT CHANGE, HOLD, AND COMMENT FORM) incorporated: |                   |                                    | 00-2346       |
| Resp Supv: CHEM  | Assoc Ref: CHEM-I | SR: N                              | Freq: 2 yrs   |
| ARMS: ODCM-01.01   | Doc Type: 7030    | Admin Initials: <i>[Signature]</i> | Date: 8/22/01 |

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**1.0 RECORD OF REVISION**

| <u>Revision No.</u> | <u>Date</u>     | <u>Reason for Revision</u>   |
|---------------------|-----------------|--|
| 1                   | December - 1998 | Corrected typo in reference to 10CFR50.36a on page 2, paragraph 1.   |
| 2                   | October - 2000  | Incorporated Tech Spec 6.8.A.1, 6.8.A.2, and 6.8.A.3 relating to ODCM control and the relocated definitions into document. |

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## **2.0 OFF-SITE DOSE CALCULATION MANUAL (ODCM) INTRODUCTION**

### **2.1 ODCM Description and Control**

- 2.1.1 In accordance with T.S.6.8.A.1, the ODCM contains the methodology and parameters used in the calculation of off-site doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm and trip setpoints, and in the conduct of the Radiological Environmental Monitoring Program.
- 2.1.2 In accordance with T.S.6.8.A.2, the ODCM also contains the radioactive effluent controls and radiological environmental monitoring activities and descriptions of the information that should be included in the Radiological Environmental Operating Program report and Radioactive Effluent Release reports required by 10CFR50, Appendix I, and 10CFR50.36a.

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## 2.2 Licensee Initiated Changes to the ODCM

- 2.2.1 In accordance with T.S.6.8.A.3, licensee initiated changes to the ODCM **SHALL** be documented and records of reviews performed **SHALL** be retained. This documentation **SHALL** contain:
- A. Sufficient information to support the change(s) together with the appropriate analyses or evaluations justifying the change(s), and
  - B. A determination that the change(s) maintain the levels of radioactive effluent control required by 10CFR20.1302, 40CFR190, 10CFR50.36a, and 10CFR50, Appendix I, and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.
- 2.2.2 Changes **SHALL** become effective after review and approval by the Plant Manager.
- 2.2.3 Changes **SHALL** be submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Radioactive Effluent Release Report for the period of the report in which any change in the ODCM was made. Each change **SHALL** be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and **SHALL** indicate the date (i.e., month and year) the change was implemented.

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## 2.3 Definitions

### 2.3.1 Abnormal Release

An unplanned or uncontrolled release of radioactive material from the plant or a gaseous release where the effluent release rate significantly exceeds an established normal release rate. A release which results from procedural or equipment inadequacies, or personnel errors, that could indicate a deficiency.

### 2.3.2 Action

ACTION **SHALL** be that part of a control which prescribes required actions to be taken under designated conditions within specified completion times.

### 2.3.3 Batch Release

A BATCH RELEASE is a discharge of liquid or gaseous radioactive effluent of a discrete volume. Prior to sampling for analysis, each batch **SHALL** be isolated and thoroughly mixed to assure representative sampling.

### 2.3.4 Instrument Calibration

An instrument calibration means the adjustment of an instrument signal output so that it corresponds, within acceptable range, accuracy, and response time to a known value(s) of the parameter which the instrument monitors. Calibration **SHALL** encompass the entire instrument including actuation, alarm or trip.

### 2.3.5 Sensor Check

A qualitative determination of operability by observation of sensor behavior during operation. This determination **SHALL** include, where possible, comparison with other independent sensor measuring the same variable.

### 2.3.6 Instrument Functional Test

An instrument functional test means the injection of a simulated signal into the primary sensor to verify proper instrument channel response, alarm, and/or initiating action.

### 2.3.7 Composite Sample

A COMPOSITE SAMPLE is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

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2.3.8 Dose Equivalent I-131

DOSE EQUIVALENT I-131 **SHALL** be that concentration of I-131 ( $\mu\text{Ci}/\text{gram}$ ) that alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid dose conversion factors used for this calculation **SHALL** be those listed in Table III of TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites" or in NRC Regulatory Guide 1.109, Revision 1, October 1977.

2.3.9 Exclusion Area Boundary

The EXCLUSION AREA BOUNDARY is the same as the Site Boundary described in ODCM-03.01 Figure 1. The EXCLUSION AREA is the area encompassed by the EXCLUSION AREA BOUNDARY.

2.3.10 Offgas Treatment System

The OFFGAS TREATMENT SYSTEM **SHALL** be any system designed and installed to reduce radioactive effluents by collecting primary coolant system offgas from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

2.3.11 Liquid Radwaste Treatment System

The LIQUID RADWASTE TREATMENT SYSTEM **SHALL** be any system designed and installed to reduce radioactive effluents by holdup or collecting radioactive materials by means of filtering, evaporation, ion exchange or chemical reaction for the purpose of reducing the total radioactivity prior to release to the environment.

2.3.12 Long Term Release

"Long-term" refers to releases that are generally continuous and stable in release rate with some anticipated variation (i.e., <50%, based on a running monthly average) in release rate, such as is experienced in normal ventilation system effluents at nuclear power plants. Determination of doses due to long-term releases should use the historical annual average relative concentration ( $\chi/Q$ ) based on meteorological data summarized, as recommended in Regulatory Guide 1.111.

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2.3.13 Members Of The Public

MEMBERS OF THE PUBLIC **SHALL** include all persons who are not occupationally associated with the plant. This category does not include employees of the utility, its contractors, or its vendors. Also excluded from this category are persons who enter the site to service equipment or to make deliveries. This category does include persons who use portions of this site for recreational, occupational, or other purposes not associated with the plant.

2.3.14 Operable - Operability

As defined in the Technical Specifications.

2.3.15 Purge - Purging

PURGE - PURGING **SHALL** be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

2.3.16 Radiological Environmental Monitoring Program (REMP)

The RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM is established for monitoring the radiation and radionuclides in the environs of the plant. The program **SHALL** provide representative measurements of radioactivity in the highest potential exposure pathways and verification of the accuracy of potential exposure pathways and verification of the accuracy of the effluent monitoring program and modeling of the environmental exposure pathways.

2.3.17 Short Term Release

"Short-term" refers to releases that are intermittent in radionuclide concentrations or flow, such as releases from drywell purges and systems or components with infrequent use. Short-term releases may be due to operational variations which result in radioactive releases greater than 50% of the releases normally considered as long-term. Short-term releases from these sources during normal operation, including anticipated operational occurrences, are defined as those which occur for a total of 500 hours or less in a calendar year but not more than 150 hours in any quarter.

2.3.18 Site Boundary

Means a line within which the land is owned, leased, or otherwise controlled by the licensee. The site boundary for liquid releases of radioactive material is defined in ODCM-02.01 Figure 1. The site boundary for gaseous releases of radioactive material is defined in ODCM-03.01 Figure 1.

|  |                     |             |
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2.3.19 Source Check

A SOURCE CHECK **SHALL** be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

2.3.20 Unrestricted Area

An UNRESTRICTED AREA means any area at or beyond the site boundary to which access is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials or any area within the site boundary used for residential quarters or industrial, commercial, institutional and/or recreational purposes.

2.3.21 Uranium Fuel Cycle

The URANIUM FUEL CYCLE is defined in 40CFR Part 190.02(b) as: "The operation of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel, to the extent that these directly support the production of electrical power for public use utilizing nuclear energy, but excludes mining operations, operations at waste disposal sites, transportation of any radioactive material in support of these operations, and the use of recovered non-uranium special nuclear and by-product materials from the cycle."

2.3.22 Venting

VENTING **SHALL** be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is NOT provided or required.

|  |                     |             |
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## 2.4 Radiological Effluent Controls And Surveillance Requirement

### 2.4.1 Controls

- A. Compliance with the controls contained within the succeeding text is required during the conditions specified. Upon failure to meet the control, the associated ACTION requirements **SHALL** be met.
- B. Noncompliance with a control **SHALL** exist when the requirements of the Control and associated ACTION requirements are not met within the specified time interval. If the Control is restored prior to expiration of the specified time interval, completion of the ACTION requirements is not required.
- C. Noncompliance with a CONTROL and associated ACTION, or a Surveillance Requirement **SHALL** be documented in the annual "Radioactive Effluent Release Report" covering the period of the noncompliance. Documentation of a noncompliance **SHALL** identify the cause of the noncompliance, define the corrective actions taken to correct the noncompliance, and a description of actions taken to prevent recurrence.

### 2.4.2 Surveillance Requirements

- A. Surveillance Requirements **SHALL** be met during the conditions specified for individual controls unless otherwise stated in an individual Surveillance Requirement.
- B. Each Surveillance Requirement **SHALL** be performed within the specified time interval with the following exceptions:
  - 1. Specified time intervals between tests may be adjusted plus 25% to accommodate normal test schedules.
- C. Failure to perform a Surveillance Requirement within the allowed surveillance interval, defined by Control B. **SHALL** constitute noncompliance with the OPERABILITY requirements for a Control for operation. The time limits of the ACTION requirements are applicable at the time it is identified that a Surveillance Requirement has not been performed. The ACTION requirements may be delayed for up to 24 hours to permit the completion of the surveillance when the allowable outage time limits of the ACTION requirements are less than 24 hours. Surveillance Requirements do not have to be performed on inoperable equipment.



|  |                         |              |
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| Prepared By: <i>B. Peterson</i>          |                  |
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| OC Final Review Meeting: # 2242          | Date: 11/02/2000 |
| Approved By Plant Manager: <i>J. Plr</i> | Date: 8/24/01    |

\*This is a major rewrite, therefore, no/sidelines are required.

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**1.0 RECORD OF REVISION**

| <u>Revision No.</u> | <u>Date</u>     | <u>Reason for Revision</u>   |
|---------------------|-----------------|--|
| 1                   | December - 1998 | Corrected reference to Table 2.1-1 from 2.1.2.   |
| 2                   | October - 2000  | Incorporated Radiological Effluents Tech Specs section 3.8.A and 4.8.A. into document. |

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## 2.0 LIQUID EFFLUENTS

### 2.1 Concentration

#### 2.1.1 Controls

- A. In accordance with T.S.6.8.D.2, the concentration of liquid radioactive material released from the site (Figure 1) **SHALL** be limited to ten times the concentration values specified in Appendix B, Table 2, Column 2 of 10CFR20.1001-20.2402 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration **SHALL** be limited to  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  total activity.

#### 2.1.2 Applicability

At all times.

#### 2.1.3 Action

- A. When the concentration of radioactive material in liquid released from the site exceeds the above limits, immediately restore the concentration within acceptable limits.
- B. Radioactive material in liquid effluent released from the site **SHALL** be continuously monitored in accordance with Table 3.
- C. The liquid effluent monitors having provisions for automatic alarms as listed in Table 3 **SHALL** be used to limit the concentration of radioactive material released at any time from the site to the values given in 2.1.1.A. Setpoints **SHALL** be determined in accordance with the methods in Section 4.0 of the ODCM.
- D. Report all deviations in the Annual Radioactive Effluent Release Report.

#### 2.1.4 Surveillance Requirements

- A. Radioactive liquid wastes **SHALL** be sampled and analyzed according to the sampling and analysis program of Table 2.
- B. The results of radioactive analysis **SHALL** be used in accordance with the methods of the ODCM to assure that the concentrations at the point of release are maintained within the limits of Control 2.1.1.A.
- C. Liquid effluent monitoring instrumentation surveillance **SHALL** be performed as required by Table 1.

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## 2.2 Dose

### 2.2.1 Controls

- A. In accordance with T.S.6.8.D.4, the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from the site **SHALL** be limited:
1. During any calendar quarter to  $\leq 1.5$  mrem to the total body and to  $\leq 5$  mrem to any organ, and
  2. During any calendar year to  $\leq 3$  mrem to the total body and to  $\leq 10$  mrem to any organ.

### 2.2.2 Applicability

At all times.

### 2.2.3 Action

- A. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that includes the following information:
1. Identifies the cause(s) for exceeding the limit(s).
  2. Defines the corrective actions taken to reduce the release.
  3. Defines the corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

### 2.2.4 Surveillance Requirements

- A. Cumulative dose contributions for the current calendar quarter and current calendar year **SHALL** be determined monthly in accordance with the ODCM.

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## 2.3 Liquid Radwaste Treatment Systems

### 2.3.1 Controls

- A. In accordance with T.S.6.8.D.6, the LIQUID RADWASTE TREATMENT SYSTEM **SHALL** be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected doses, due to the liquid effluent from the site would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ when averaged over one month.

### 2.3.2 Applicability

At all times.

### 2.3.3 Action

- A. With radioactive liquid waste being discharged without treatment and in excess of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that includes the following information:
1. Identification of the inoperable equipment or subsystems, and the reason for the inoperability.
  2. Action(s) to be taken to restore equipment to OPERABLE status, and
  3. Summary description of action(s) taken to prevent a recurrence.

### 2.3.4 Surveillance Requirements

- A. Doses due to liquid releases **SHALL** be projected at least once each month in accordance with the ODCM.

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## 2.4 Liquid Holdup Tanks

### 2.4.1 Controls

- A. In accordance with T.S.6.8.1.3, the quantity of radioactive material contained in each outside temporary tank **SHALL** be limited to  $\leq 10$  curies, excluding tritium and dissolved or entrained gases.

### 2.4.2 Applicability

At all times.

### 2.4.3 Action

- A. With the quantity of radioactive material contained in any outside temporary tank exceeding the limit in 2.4.1.A. above, immediately suspend all additions of radioactive material to the tank and within 48 hours reduce the tank contents to within the limit.

### 2.4.4 Surveillance Requirements

- A. The quantity of radioactive material contained in each outside temporary tank **SHALL** be determined to be within the limit in 2.4.1.A. by analyzing a representative sample of the tank's contents at least weekly when radioactive materials are being added to the tank.

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## 2.5 Bases

### 2.5.1 Liquid Effluents

#### A. Concentration

Control 2.1.1.A. is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to Unrestricted Areas will be less than 10 times the concentration values specified in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402. The control provides operational flexibility for releasing liquid effluents in concentrations to follow the Section II.A and II.C design objectives of Appendix I to 10CFR Part 50. This limitation provides reasonable assurance that the levels of radioactive materials in bodies of water in Unrestricted Areas will result in exposures within (1) the Section II.A design objectives of Appendix I, 10CFR Part 50, to a Member of the Public and (2) restrictions authorized by 10CFR20.1301(e). The concentration limit for the dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radionuclide and its effluent concentration in air (submersion) was converted to an equivalent concentration in water. This control does not affect the requirement to comply with the annual limitations of 10CFR20.1301(a).

#### B. Dose

Control 2.2.1.A. is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10CFR Part 50. Action required by Control 2.2.1 provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable". Considering that the nearest drinking water supply using the receiving water is 33 river miles downstream, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40CFR141.

The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents will be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with

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10CFR50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Revision 1," April 1977. NUREG-0133, October 1978 provides methods for dose calculations consistent with Regulatory Guides 1.109 and 1.113.

C. Liquid Radwaste Treatment Systems

Control 2.3.1.A. provides assurance that the liquid radwaste treatment system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirements that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This control implements the requirements of 10CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10CFR Part 50 and design objective Section II.D of Appendix I to 10CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the guide set forth in Section II.A of Appendix I, 10CFR Part 50, for liquid effluents.

The radioactive liquid effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The Alarm/Trip Setpoint for these instruments **SHALL** be calculated and adjusted in accordance with the methodologies and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR Part 50.

D. Liquid Holdup Tanks

Restrictions on the quantity of radioactive liquid material contained in tanks are required only for temporary tanks. All exterior permanent tanks are diked to prevent release of their contents in the event of leakage. Restricting the quantity of radioactive material contained in the specified tanks provides assurance that in the event of an uncontrolled release of the tanks contents, the resulting concentrations would be less than the values given in Appendix B, Table 2, Column 2, to 10CFR20.1001-20.2402 at the nearest potable water supply and the nearest surface water supply in an unrestricted area.



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Surveillance requirements for continuous liquid release points are not provided since all Monticello releases are "batch" type releases.

Radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm setpoints for these instruments will be calculated in accordance with NRC approved methods in the ODCM to ensure that the alarm will occur prior to exceeding the limits of 10CFR20. The operability requirements for instrumentation are consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR Part 50.

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Figure 1 Monticello Nuclear Generating Plant Site Boundary for Liquid Effluents

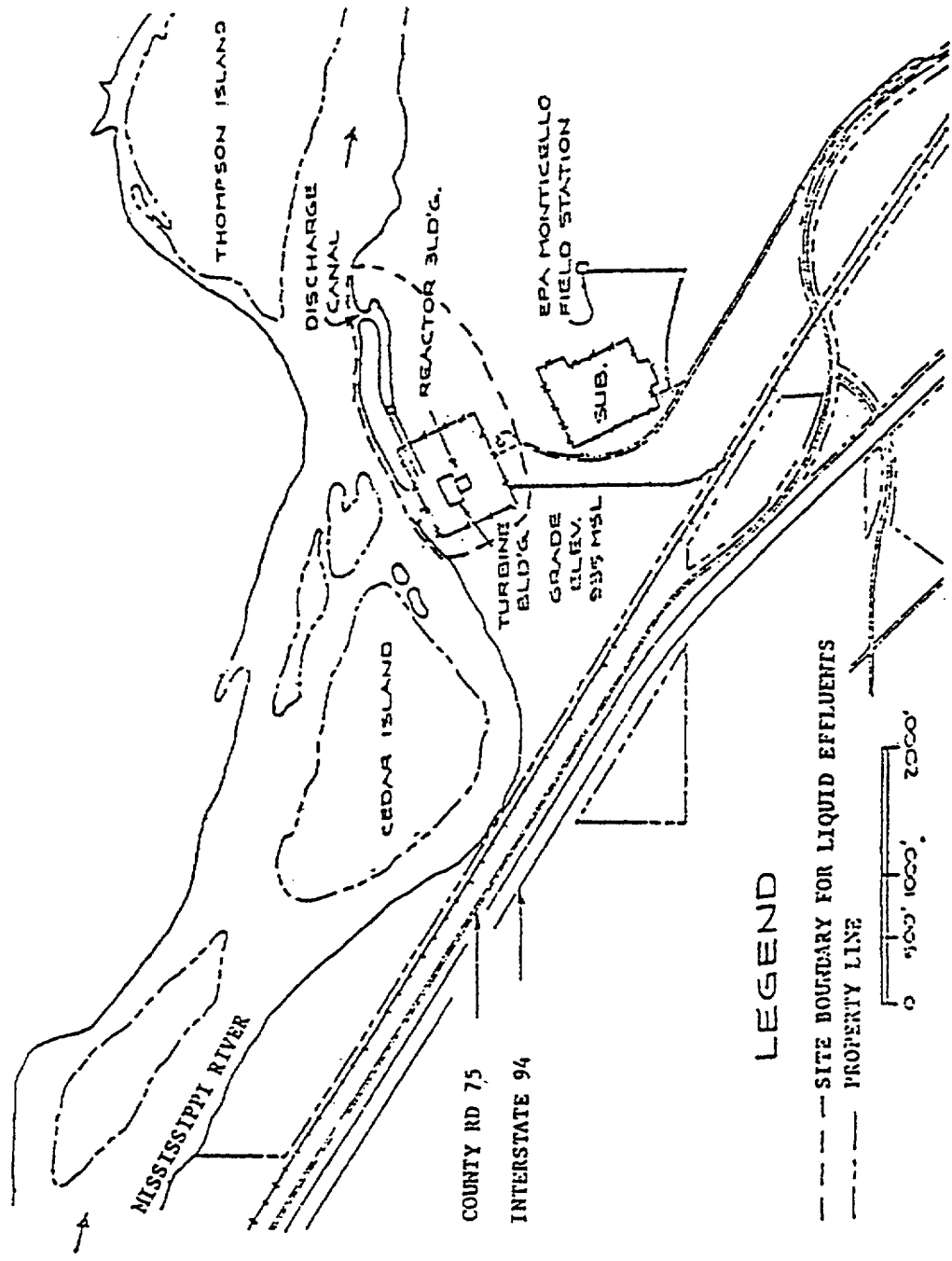


Table 1 Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

| Instrument  | Sensor Check Frequency | Source Check Frequency            | Functional Test Frequency                 | Calibration Frequency                        |
|---|------------------------|-----------------------------------|---|--|
| Liquid Radwaste Effluent Line Gross Radioactivity Monitor             | Daily during release   | Immediately Prior to Each Release | Within 3 months prior to making a release | Within 12 months prior to making a release.* |
| Liquid Radwaste Effluent Line Flow Instrument                         | Daily during release   | -                                 | Within 3 months prior to making a release | Within 12 months prior to making a release.  |
| Instruments used in Determination of Discharge Canal Flow             | Daily during release   | -                                 | Within 3 months prior to making a release | Within 18 months prior to making a release.  |
| Service Water Discharge Pipe Gross Radioactivity Monitor              | Daily                  | Monthly                           | Quarterly                                 | Each Operating Cycle*                        |
| Discharge Canal Gross Radioactivity Monitor                           | Daily                  | Monthly                           | Quarterly                                 | Each Operating Cycle **                      |
| Turbine Building Normal Drain Sump Monitor                            | Daily                  | Monthly                           | Quarterly                                 | Each Operating Cycle                         |
| Level Monitors for Temporary Outdoor Tanks Holding Radioactive Liquid | Daily when in use      | -                                 | Quarterly when in use                     | Each Operating Cycle when in use             |

\* - The initial Instrument Calibration **SHALL** be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using sources traceable to NBS standards. These standards **SHALL** permit calibrating the system over its intended range of energy and measurement range. For subsequent calibration sources that have been related to the initial calibration **SHALL** be used.

\*\* - An initial Instrument Calibration was performed using a liquid reference standard over the systems intended range of energy and measurement range. Solid calibration sources traceable to NBS Standards currently being applied for instrument calibrations were related to the initial calibration. If, in the future, the canal radioactivity monitor is replaced, the following conditions **SHALL** apply:

- a. Detector response and system efficiency **SHALL** be equal to or better than the present system.
- b. Footnote (\*) **SHALL** apply

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Table 2 Radioactive Liquid Waste Sampling And Analysis Program

| Liquid Release Type                    | Sampling Frequency   | Minimum Analysis Frequency       | Type of Activity Analysis             | Lower Limit of Detection (LLD) (uci/ml) <sup>a,e</sup> |
|--|----------------------|----------------------------------|---------------------------------------|--|
| Batch Waste Release Tanks <sup>b</sup> | Each Batch           | Each Batch                       | Principal Gamma Emitters <sup>d</sup> | $5 \times 10^{-7}$                                     |
|  |                      |                                  | I-131                                 | $1 \times 10^{-6}$                                     |
|  | One Batch Each Month | One Batch Each Month             | Dissolved and Entrained Gases         | $1 \times 10^{-5}$                                     |
|  | Each Batch           | Monthly Composite <sup>c</sup>   | H-3                                   | $1 \times 10^{-5}$                                     |
|  |                      |                                  | Gross alpha                           | $1 \times 10^{-7}$                                     |
|  | Each Batch           | Quarterly Composite <sup>c</sup> | Sr-89, Sr-90                          | $5 \times 10^{-8}$                                     |
|  |                      |                                  | Fe-55                                 | $1 \times 10^{-6}$                                     |

Table 2 Radioactive Liquid Waste Sampling And Analysis Program (cont'd)

|                                     |                  |
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**Notes**

- a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66 s_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \Delta t)}$$

where:

LLD is the a priori lower limit of detection as defined above (as picocurie per unit mass or volume),

$s_b$  is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute). Typical values of E, V, Y and  $\Delta t$  **SHALL** be used in the calculations.

E is the counting efficiency (as counts per transformation),

V is the sample size (in units of mass or volume),

2.22 is the number of transformations per minute per picocurie,

Y is the fractional radiochemical yield (when applicable),

$\lambda$  is the radioactive decay constant for the particular radionuclide, and

$\Delta t$  is the elapsed time between midpoint of sample collection and time of counting.

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Table 2 Radioactive Liquid Waste Sampling And Analysis Program (cont'd)

- b. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch **SHALL** be isolated and then thoroughly mixed to assure representative sampling.
- c. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.
- d. The principle gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, **SHALL** also be identified and reported.
- e. Nuclides which are below the LLD for the analyses **SHALL** be reported as "less than" the LLD of the nuclide and should not be reported as being present at the LLD level for that nuclide. The "less than" values **SHALL** not be used in the required dose calculations. When unusual circumstances result in LLDs higher than required, the reasons **SHALL** be documented in the Radioactive Effluent Release Report.

| Instrument   | Minimum Channels Operable | Applicability                     | Action if Minimum Channels not operable   |
|--|---------------------------|-----------------------------------|---|
| Liquid Radwaste Effluent Line Gross Radioactivity Monitor                            | 1                         | During Release of Liquid Radwaste | <p>Liquid radwaste releases may continue for up to 14 days provided that prior to initiating a release:</p> <ul style="list-style-type: none"> <li>a. At least two independent samples are analyzed in accordance with Table 2.</li> <li>b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving;</li> </ul> <p>Otherwise, suspend release of radioactive effluents via this pathway.</p> |
| Liquid Radwaste Effluent Flow Instrument   | 1                         | During Release of Liquid Radwaste | <p>Liquid radwaste releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least every four hours during actual releases. Pump curves may be used to estimate flow.</p>   |
| Discharge Canal Flow Measurement:<br>- Open Cycle Mode<br>- Closed/Helper Cycle Mode | 1<br>1                    | During Release of Liquid Radwaste | <p>Effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once every four hours during actual releases. Pump curves may be used to estimate flow.</p>   |
| Discharge Canal Gross Radioactivity Monitor*   | 1                         | At all times                      | <p>Effluent releases may continue for up to 30 days provided that at least once every 8 hours a grab sample <b>SHALL</b> be collected and analyzed for gross beta at an LLD of <math>10^{-7}</math> <math>\mu\text{Ci/ml}</math> or gamma isotopic for principle gamma emitters at an LLD of <math>5.0 \times 10^{-7}</math> <math>\mu\text{Ci/ml}</math>.</p>  |

\* - Indicates monitor provided with automatic alarm.

Table 3 Radioactive Liquid Effluent Monitoring Instrumentation

|  |                         |
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Table 3 Radioactive Liquid Effluent Monitoring Instrumentation (cont'd)

| Instrument  | Minimum Channels Operable | Applicability         | Action if Minimum Channels not operable   |
|---|---------------------------|-----------------------|---|
| Service Water Discharge Pipe Gross Radioactivity Monitor*             | 1                         | At all times          | Service water discharge may continue for up to 30 days provided that at least once every 8 hours a grab sample <b>SHALL</b> be collected and analyzed for gross beta at an LLD of $10^{-7}$ $\mu$ Ci/ml or gamma isotopic for principle gamma emitters at an LLD of $5.0 \times 10^{-7}$ $\mu$ Ci/ml. |
| Turbine Building Normal Sump Monitor*                                 | 1                         | At all times          | Liquid sump releases may continue for up to 30 days provided that at least once every 8 hours a grab sample <b>SHALL</b> be collected and analyzed for gross beta at an LLD of $10^{-7}$ $\mu$ Ci/ml or gamma isotopic for principle gamma emitters at an LLD of $5.0 \times 10^{-7}$ $\mu$ Ci/ml.    |
| Level Monitors for Temporary Outdoor Tanks Holding Radioactive Liquid | 1                         | When tanks are in use | Liquid additions to a tank may continue for up to 30 days provided the tank level is estimated during all liquid additions.   |

\* - Indicates monitor provided with automatic alarm.



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| Reviewed By: <i>M. Thomas</i>  |                       |
| OC Final Review Meeting: <i>2293 - F</i>                                     | Date: <i>11/15/01</i> |
| Approved By Plant Manager: <i>[Signature]</i>                                | Date: <i>11/17/01</i> |
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**1.0 RECORD OF REVISION**

| <u>Revision No.</u> | <u>Date</u>     | <u>Reason for Revision</u>   |
|---------------------|-----------------|--|
| 1                   | August - 1995   | <p>Page 3 of 23, 2nd paragraph - Changed "In addition, prior to containment purge and venting," to "In addition, prior to containment purging". This change was made because setpoint recalculation is required only for containment purging and to be consistent with the rest of the ODCM.</p> <p>Page 3 of 23, first paragraph - Changed "Reactor Building Vent Plenum Monitor which initiates isolation of Reactor Building releases" to "Reactor Building Vent Noble Gas Monitor". This change was made to differentiate the noble gas monitor from the plenum radiation monitor and because the isolation function has been removed from the noble gas monitor system.</p> <p>Page 3 of 23, section 1.1.1 - Changed "Reactor Building Vent Isolation Setpoint" to "Reactor Building Vent Alarm Setpoint". This change was made because the setpoint exceedance no longer causes the Reactor Building Vent to isolate.</p> <p>Page 4 of 23, Section 1.1.1.B - Changed "For purge releases, substitute (x/q)v, the highest short term dispersion factor from Table A-12" to "For purge releases, substitute the value obtained from Chemistry Manual Procedure I.06.07 (ATMOSPHERIC DISPERSION DETERMINATION)". This change was made to more accurately predict off-site dose from containment purging by using near real time actual dispersion values.</p> |
| 2                   | October - 2000  | Incorporated Radiological Effluents Tech Specs section 3.8.B and 4.8.B into document.  |
| 3                   | November - 2001 | Added clarification to section 2.4.1.A. and 2.4.3.A. to more accurately describe Off-gas Treatment System operation requirements. Corrected reference in Note h. of Table 2.   |

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## 2.0 GASEOUS EFFLUENTS

### 2.1 Dose Rate

#### 2.1.1 Controls

- A. In accordance with T.S.6.8.D.7, the dose rate due to radioactive materials released in gaseous effluents from the site (Figure 1) **SHALL** be limited to the following:
1. For Noble Gases: Less than or equal to a dose rate of 500 mrem/yr to the total body and less than or equal to a dose rate of 3000 mrem/yr to the skin, and
  2. For Iodine-131, Iodine-133, Tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to a dose rate of 1500 mrem/yr to any organ.

#### 2.1.2 Applicability

At all times.

#### 2.1.3 Action

- A. With the dose rate(s) exceeding the above limits, immediately decrease the release rate to within acceptable limits(s).
- B. Radioactive material in gaseous effluents released from the site **SHALL** be continuously monitored in accordance with Table 3.
- C. The Noble Gas Effluent monitors having provisions for the automatic termination of gaseous releases, as listed in Table 3 **SHALL** be used to limit off-site dose rates to the values established in 2.1.1.A.1. Setpoints **SHALL** be determined in accordance with the ODCM.

#### 2.1.4 Surveillance Requirements

- A. Gaseous effluent monitoring instrument surveillance **SHALL** be performed as required by Table 1.
- B. The release rate due to Iodine-131, Iodine-133, Tritium, and Radioactive Particulates with half-lives greater than 8 days **SHALL** be determined by obtaining representative samples and performing analysis in accordance with the sampling and analysis program specified in Table 2. Following each analysis, the dose rate due to I-131, I-133, Tritium and Radioactive Particulates with half-lives greater than 8 days, **SHALL** be determined to be less than the limit in 2.1.1.A.2. in accordance with the ODCM.

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## 2.2 Dose - Noble Gases

### 2.2.1 Controls

- A. In accordance with T.S.6.8.D.8, the air dose due to noble gases released in gaseous effluents from the site (Figure 1) **SHALL** be limited to the following values:
1. During any calendar quarter:  $\leq 5$  mrad for gamma radiation and  $\leq 10$  mrad for beta radiation, and
  2. During any calendar year:  $\leq 10$  mrad for gamma radiation and  $\leq 20$  mrad for beta radiation.

### 2.2.2 Applicability

At all times.

### 2.2.3 Action

- A. With the calculated air dose from radioactive noble gases in gaseous effluent exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that includes the following:
1. Identifies the cause(s) for exceeding the limit(s).
  2. Defines the corrective actions taken to reduce the release.
  3. Defines the proposed corrective actions to be taken to assure that subsequent releases will be within the above limits.

### 2.2.4 Surveillance Requirements

- A. Cumulative dose contributions for the current calendar quarter and current calendar year from noble gases in gaseous effluents **SHALL** be determined monthly in accordance with the ODCM.

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**2.3 Dose - Iodine-131, Iodine-133, Tritium and Particulates**

**2.3.1 Controls**

A. In accordance with T.S.6.8.D.9, the dose to any organ of an individual due to Iodine-131, Iodine-133, Tritium, and radioactive particulates with a half-life greater than 8 days released from the site (FIGURE 1) in gaseous effluent **SHALL** be limited to the following:

1. During any calendar quarter:  $\leq 7.5$  mrem, and
2. During any calendar year:  $\leq 15$  mrem.

**2.3.2 Applicability**

At all times.

**2.3.3 Action**

A. With the calculated dose from the release of Iodine-131, Iodine-133, Tritium, and Radioactive Particulates with half-lives greater than 8 days, exceeding any of the above limits, in lieu of a Licensee Event Report, prepare and submit to the Commission within 30 days a Special Report that includes the following:

1. Identifies the cause(s) for exceeding the limit(s).
2. Defines the corrective actions taken to reduce the release.
3. Defines the proposed corrective actions to be taken to assure that the subsequent releases will be within the above limits.

**2.3.4 Surveillance Requirements**

A. Cumulative dose contributions for the current calendar quarter and current calendar year for Iodine-131, Iodine-133, Tritium, and Radioactive Particulates with half-lives greater than 8 days in gaseous effluents **SHALL** be determined in accordance with the ODCM monthly.

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## 2.4 Off-gas Treatment System

### 2.4.1 Controls

- A. In accordance with T.S.6.8.D.6, the OFF-GAS TREATMENT SYSTEM **SHALL** be in operation whenever the Main Condenser Air Ejector system is in operation except during Plant Startup or Plant Shutdown. Components of the system **SHALL** be operated to provide the maximum holdup time obtainable except during periods of equipment maintenance or when off-gas recombiner outlet hydrogen or oxygen concentrations are out of specification.
- B. The quantity of radioactivity after 12 hours holdup contained in each gas storage tank **SHALL** be limited to  $\leq 22,000$  curies of noble gases (considered as dose equivalent Xe-133).
- C. The concentration of hydrogen in the compressed storage subsystem **SHALL** be limited to  $\leq 2\%$  by volume. With the concentration of hydrogen  $> 2\%$  by volume, but  $\leq 4\%$  by volume, restore the concentration of hydrogen to  $< 2\%$  by volume within 48 hours or suspend operation of the compressed storage subsystem.
- D. The hydrogen monitors **SHALL** be operable as specified in Table 3 and set to automatically trip the off-gas compressors at  $\leq 4\%$  hydrogen by volume.

### 2.4.2 Applicability

At all times.

### 2.4.3 Action

- A. With gaseous waste being discharged for more than seven (7) days with an average holdup time of less than 50 hours, document and report IAW ODCM-01.01, Section 2.4.1.C.

### 2.4.4 Surveillance Requirements

- A. Following each isotopic analysis of a sample of gases from the Main Condenser Off-gas System Pretreatment monitor station required by Tech Spec 3.8.A, verify that the maximum storage tank activity limit specific in 2.4.1.B. cannot be exceeded using the method in the ODCM.

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## 2.5 Main Condenser Off-Gas Activity

### 2.5.1 Controls

- A. In accordance with T.S.3.8.A.1, whenever the Steam Jet Air Ejectors (SJAEs) are in operation, the gross gamma activity rate of the noble gases measured at the Main Condenser Off-gas System Pretreatment Monitor station **SHALL** be  $\leq 2.6 \times 10^5$   $\mu\text{Ci}/\text{sec}$  after a decay of 30 minutes.
- B. The activity of radioactive material in gaseous form removed from the main condenser **SHALL** be continuously monitored by the Main Condenser Off-Gas Pretreatment monitors in accordance with Table 3.
- C. The Main Condenser Off-Gas Pretreatment monitors **SHALL** be set to automatically terminate off-gas flow within 30 minutes at the limit established in 2.5.1.A.

### 2.5.2 Applicability

At all times

### 2.5.3 Action

- A. When the gross gamma activity rate of the noble gases is not within the limit of 2.5.1.A above, restore gross gamma activity rate of the noble gases to within the limit within 72 hours.
- B. When 2.5.3.A cannot be met, either:
  - 1. Isolate all main steam lines within 12 hours; or
  - 2. Isolate the SJAEs within 12 hours; or
  - 3. Be in hot shutdown within 12 hours and cold shutdown within the following 24 hours.

### 2.5.4 Surveillance Requirements

- A. The gross gamma radioactivity of noble gases from the main condenser air ejector **SHALL** be determined to be within the limit specified in 2.5.1.A at the following times by performing an isotopic analysis of a representative sample of gases:
  - 1. Once every month
  - 2. Within 4 hours following an increase in the continuous monitor reading of 50% after factoring out increases due to power level.

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## 2.6 Containment Venting and Purging

### 2.6.1 Controls

- A. In accordance with T.S.6.8.D.11 and 3.7.A.5.C, except for inerting operations following startup and deinerting prior to shutdown, containment venting and purging above cold shutdown **SHALL** be via the 2-inch bypass flow path using the Standby Gas Treatment System.
- B. In accordance with T.S.6.8.D.11, Containment inerting following startup and deinerting prior to shutdown **SHALL** be via the Reactor Building plenum and vent.

### 2.6.2 Applicability

At all times.

### 2.6.3 Action

None

### 2.6.4 Surveillance Requirements

- A. Except for inerting operations following startup and deinerting prior to shutdown, the containment **SHALL** be determined to be aligned for venting or purging through the Standby Gas Treatment System within four (4) hours prior to start of and at least once per 12 hours during venting or purging of the containment above cold shutdown.
- B. Prior to containment purging, the sampling and analysis requirements of Table 2 **SHALL** be met.



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## 2.7 Bases

### 2.7.1 Gaseous Effluents

#### A. Dose Rate

Control 2.1.1.A. provides reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a Member of the Public in an Unrestricted Area, either at or beyond the Site Boundary in excess of the design objectives of Appendix I to 10CFR Part 50. This specification is provided to ensure that gaseous effluents from all units on the site will be appropriately controlled. It provides operational flexibility for releasing gaseous effluents to satisfy the Section II.A and II.C design objectives of Appendix I to 10CFR Part 50. For Members of the Public who may at times be within the Site Boundary, the occupancy of that Member of the Public will usually be sufficiently low to compensate for the reduced atmospheric dispersion of gaseous effluents relative to that for the Site Boundary. The specified release rate limits restrict, at all times, the corresponding dose rates above background to a Member of the Public at or beyond the Site Boundary to less than or equal to 500 mrem/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrem/year. This specification does not affect the requirement to comply with the annual limitations of 10CFR20.1301(a).

#### B. Dose From Noble Gas

Control 2.2.1.A. is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10CFR Part 50. Action required by Control 2.2.1 provides the required operating flexibility and at the same time implements the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as reasonably achievable".

The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents will be consistent with the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with

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10CFR Part 50, Appendix I," Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. The ODCM equations provided for determining the air doses at the restricted area boundary may be based upon the historical average atmospheric conditions. NUREG-0133, October, 1978 provides methods for dose calculations with Regulatory Guides 1.109 and 1.111.

C. Dose From Iodine 131, Iodine 133, Tritium & Particulates

Control 2.3.1.A. is provided to implement the requirements of Section II.C, III.A and IV.A of Appendix I, 10CFR Part 50. The release rate specifications for I-131, I-133, tritium and radioactive particulates with half-lives greater than eight days are dependent on the existing radionuclide pathways to man in the Unrestricted Area. The pathways which are examined in the development of these calculations are: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

D. Off-gas Treatment Systems

Control 2.4.1.A. provides assurance that the Off-gas Treatment System will be in operation whenever main condenser off-gas is released to the environment. The requirement that the appropriate portions of this system be used when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10CFR50.36a, General Design Criterion 60 of Appendix A to 10CFR Part 50, and design objective Section II.D of Appendix I to 10CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the guide set forth in Sections II.B and II.C of Appendix I, 10CFR Part 50, for gaseous effluents.

Control 2.4.1.B. is provided to limit the radioactivity which can be stored in one decay tank. Restricting the quantity of radioactivity contained in each gas storage tank provides assurance that in the event of an uncontrolled release of the tank's contents, the resulting total body exposure to an individual at the site Restricted Area Boundary will not exceed 20 mrem. A flow restrictor in the discharge line of the decay tanks prevents a tank from being discharged at an uncontrolled rate. In addition, interlocks prevent the contents of a tank from being released with less than 12 hours of holdup.

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The radioactive gaseous effluent monitoring instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The Alarm/Trip Setpoint for these instruments will be calculated in accordance with NRC approved methods in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10CFR Part 20. The OPERABILITY requirements for this instrumentation are consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10CFR Part 50.

**E. Main Condenser Off-Gas Activity**

Control 2.5.1.A. establishes a maximum activity at the steam jet air ejector. Restricting the gross radioactivity rate of noble gases from the main condenser provides reasonable assurance that the total body exposure to an individual at the restricted area boundary will not exceed the limits of 10CFR Part 20 in the event this effluent is inadvertently discharged directly to the environment with minimal treatment. This control implements the requirements of General Design Criteria 60 and 64 of Appendix A to 10CFR Part 50.

**F. Containment Venting and Purging**

Control 2.6.1 requires the containment to be purged and vented through the standby gas treatment system except during inerting and deinerting operations. This provides for iodine and particulate removal from the containment atmosphere. During outages when the containment is opened for maintenance, the containment ventilation exhaust is directed to the monitored reactor building vent. Use of the 2 inch flow path prevents damage to the standby gas treatment system in the event of a loss of coolant accident during purging or venting. Use of the reactor building plenum and vent flow path for inerting and deinerting operations permits the control room operators to monitor the activity level of the resulting effluent by use of the Reactor Building Vent Wide Range Gas Monitors. In the event that the Reactor Building release rate exceeds the Reactor Building Vent Wide Range Gas Monitor alarm settings, the monitors will alarm in the Control Room alerting the operators to take actions to limit the release of gaseous radioactive effluents. The alarm settings for the Reactor Building Vent Wide Range Gas Monitors are calculated in accordance with the NRC approved methods in the ODCM to ensure that alarms will alert Control Room Operators prior to the limits of 10CFR Part 20 being exceeded.

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Figure 1 Monticello Nuclear Generating Plant Site Boundary for Gaseous Effluents

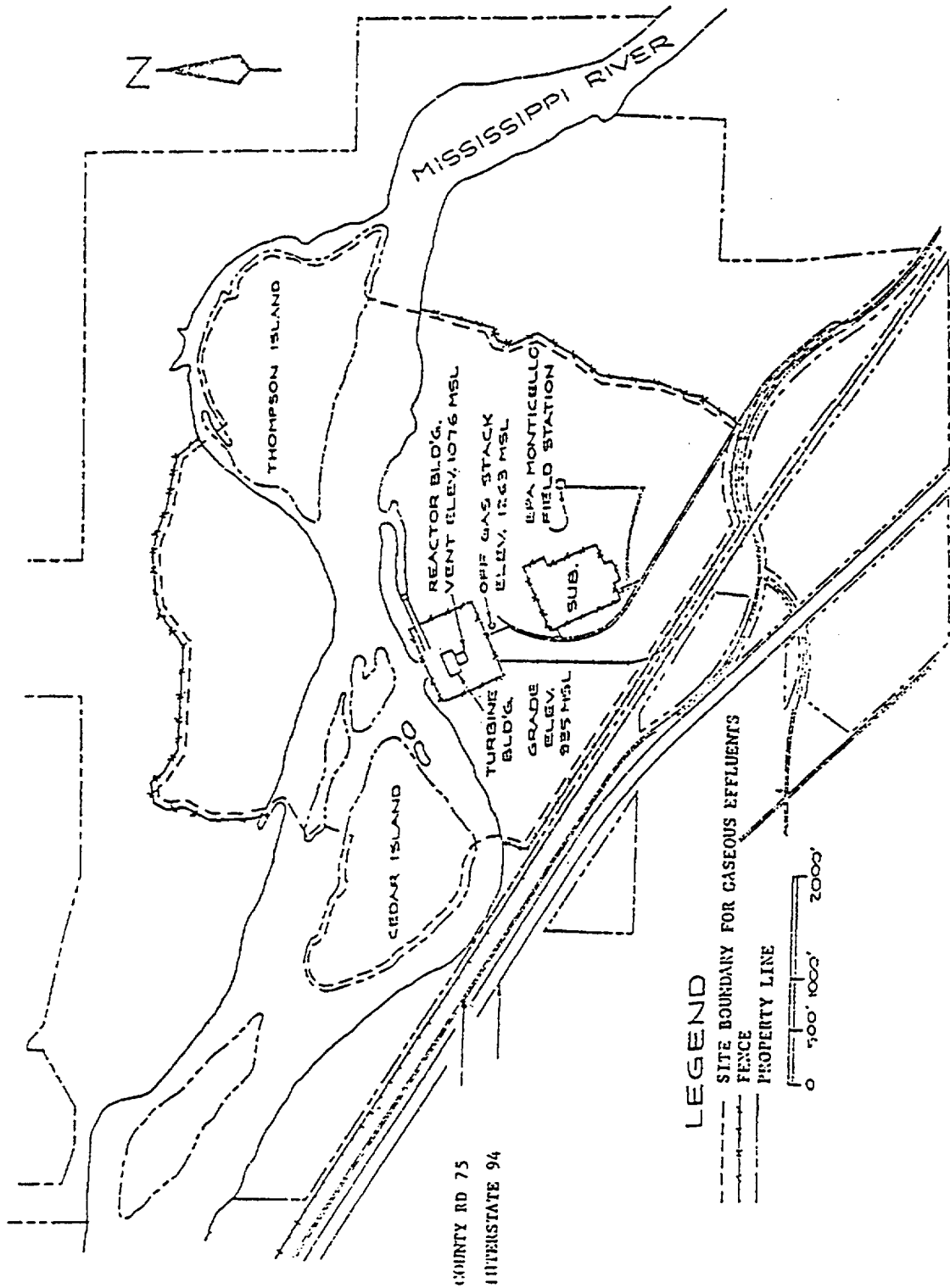


Table 1 Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

| Instrument   | Sensor Check Frequency             | Source Check Frequency | Functional Test Frequency | Calibration Frequency      |
|--|------------------------------------|------------------------|---------------------------|----------------------------|
| Main Condenser Air Ejector Noble Gas Activity Monitors       | Daily during air ejector operation |                        | Quarterly                 | Once each Operating Cycle  |
| Main Condenser Off-gas Treatment System Hydrogen Monitors    | Daily during air ejector operation |                        | Monthly                   | Quarterly#                 |
| Plant Stack Wide Range Noble Gas Activity Monitors           | Daily                              | Monthly                | Quarterly                 | Once each Operating Cycle* |
| Plant Stack Iodine and Particulate Samplers                  | Weekly                             |                        |                           |                            |
| Plant Stack Flow Monitor                                     | Daily                              |                        |                           | Once each Operating Cycle  |
| Plant Stack Sample Flow Instruments                          | Daily                              |                        |                           | Once each Operating Cycle  |
| Reactor Building Vent Wide Range Noble Gas Activity Monitors | Daily                              | Monthly                | Quarterly                 | Once each Operating Cycle* |
| Reactor Building Vent Iodine and Particulate Samplers        | Weekly                             |                        |                           |                            |
| Reactor Building Vent Duct Flow Monitors                     | Daily                              |                        |                           | Once each Operating Cycle  |
| Reactor Building Vent Sample Flow Instruments                | Daily                              |                        |                           | Once each Operating Cycle  |

- \* - The initial Instrument Calibration **SHALL** be performed using one or more of the reference standards certified by the National Bureau of Standards (NBS) or using sources traceable to NBS standards. These standards **SHALL** permit calibrating the system over its intended range of energy and measurement range. For subsequent calibration sources that have been related to the initial calibration **SHALL** be used.
- # - The Calibration **SHALL** include the use of standard gas samples containing a nominal four volume percent hydrogen.

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Table 2 Radioactive Gaseous Waste Sampling and Analysis Program

| Gaseous Release Type                  | Sampling Frequency               | Minimum Analysis Frequency                          | Type of Activity Analysis                    | Lower Limit of Detection (LLD) (uci/m) <sup>a,e,f</sup> |
|---------------------------------------|----------------------------------|---|--|---|
| Containment Purge                     | Each Purge Grab Sample           | Each Purge  | Principal Gamma Emitters(f)                  | $1 \times 10^{-4}$                                      |
|                                       |                                  |   | H-3 <sup>h</sup>                             | $1 \times 10^{-6}$                                      |
| Plant Stack and Reactor Building Vent | Monthly <sup>b</sup> Grab Sample | Monthly   | Principal Gamma Emitters(f)                  | $1 \times 10^{-4}$                                      |
|                                       |                                  |   | H-3 <sup>i</sup>                             | $1 \times 10^{-6}$                                      |
|                                       | Continuous <sup>g</sup>          | Weekly <sup>c</sup> Charcoal Sample                 | I-131<br>I-133                               | $1 \times 10^{-12}$<br>$1 \times 10^{-10}$              |
|                                       | Continuous <sup>g</sup>          | Weekly <sup>c</sup> Particulate Sample              | Principal Gamma Emitters (I-131, Others)     | $1 \times 10^{-11}$                                     |
|                                       | Continuous <sup>g</sup>          | Monthly <sup>d</sup> Composite Particulate Sample   | Gross alpha                                  | $1 \times 10^{-11}$                                     |
|                                       | Continuous <sup>g</sup>          | Quarterly <sup>d</sup> Composite Particulate Sample | Sr-89, Sr-90                                 | $1 \times 10^{-11}$                                     |
|                                       | Continuous <sup>g</sup>          | Composite monitor                                   | Gross gamma or gross beta noble gas activity | $1 \times 10^{-6}$                                      |

**Notes**

- a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal. Note (a) of Table 2 is applicable.
- b. Grab samples taken at the discharge of the plant stack and Reactor Building vent are generally below minimum detectable levels for most nuclides with existing analytical equipment. For this reason, isotopic analysis data, corrected for holdup time, for samples taken at the steam jet air ejector may be used to calculate noble gas ratios.
- c. Whenever the steady state radioiodine concentration is greater than 10 percent of the limit of Specification 3.6.C.1, daily sampling of reactor coolant for radioactive iodines of I-131 through I-135 is required. Whenever a change of 25% or more in calculated Dose Equivalent I-131 is detected under these conditions, the iodine and particulate collection devices for all release points **SHALL** be removed and analyzed daily until it is shown that a pattern exists which can be used to predict the release rate. Sampling may then revert to weekly. When samples collected for one day are analyzed, the corresponding LLDs may be increased by a factor of 10. Samples **SHALL** be analyzed within 48 hours after removal.
- d. To be representative of the average quantities and concentrations of radioactive materials in particulate form in gaseous effluents, samples should be collected in proportion to the rate of flow of the effluent streams.
- e. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, **SHALL** also be identified and reported.
- f. Nuclides which are below the LLD for the analyses **SHALL** be reported as "less than" the LLD of the nuclide and should not be reported as being present at the LLD level for that nuclide. The "less than" values **SHALL NOT** be used in the required dose calculations. When unusual circumstances result in LLDs higher than reported, the reasons **SHALL** be documented in the semiannual effluent report.
- g. The ratio of the sample flow rate to the sampled stream flow rate **SHALL** be known for the time period sampled.
- h. H<sup>3</sup> analysis **SHALL** not be required prior to purging if the limits of control 2.1.1 are satisfied for other nuclides. However, the H<sup>3</sup> analysis **SHALL** be completed within 24 hours after sampling.
- i. In lieu of grab samples, continuous monitoring with bi-weekly analysis using silica-gel samplers may be provided.

Table 2 Radioactive Gaseous Waste Sampling and Analysis Program (cont'd)

|                                     |  |               |
|-------------------------------------|--|---------------|
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| Instrument  | Minimum Channels Operable | Applicability                | Action if Minimum Channels not Operable   |
|---|---------------------------|------------------------------|---|
| Main Condenser Air Ejector Noble Gas Activity Monitor     | 2                         | During air ejector operation | From and after the date that one of the two steam jet air ejector off-gas radiation monitors is made or found to be inoperable, continued reactor power operation is permissible provided the inoperable radiation monitor instrument channel is tripped. Upon loss of both steam jet air ejector off-gas radiation monitors, be in Hot Standby within six hours. |
| Main Condenser Off-gas Treatment System Hydrogen Monitors | 2#                        | During air ejector operation | Operation may continue for up to 14 days with one Operable channel per operating recombiner train. With all channels inoperable, be in Hot Standby within six hours.  |
| Plant Stack   |                           |                              |   |
| Wide Range Noble Gas Activity Monitors*                   | 1                         | At all times                 | Releases via this pathway may continue for up to 30 days provided grab samples are taken and analyzed at least once every 8 hours.  |
| Iodine Sampler Cartridge                                  | 1                         | At all times                 | Releases via this pathway may continue for up to 30 days provided within 8 hours samples are continuously collected with auxiliary sampling equipment as required by Table 2.   |
| Particulate Sampler Filter                                | 1                         | At all times                 | Releases via this pathway may continue for up to 30 days provided within 8 hours samples are continuously collected with auxiliary sampling equipment as required by Table 2.   |
| Stack Flow Monitor  | 1                         | At all times                 | Releases via the pathway may continue for up to 30 days provided the flow rate is estimated at least once every 4 hours.  |
| Sample Flow Instrument                                    | 1                         | At all times                 | Releases via the pathway may continue for up to 30 days provided the flow rate is estimated at least once every 4 hours.  |

Table 3 Radioactive Gaseous Effluent Monitoring Instrumentation

|  |                          |
|--|--------------------------|
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| Instrument   | Minimum Channels Operable | Applicability | Action if Minimum Channels not Operable   |
|--|---------------------------|---------------|---|
| Reactor Building Vent (includes Turbine Building & Radwaste Building releases)<br>Wide Range Noble Gas Activity Monitors** | 1                         | At all times  | Releases via this pathway may continue for up to 30 days provided grab samples are taken and analyzed at least every 8 hours.   |
| Iodine Sampler Cartridge   | 1                         | At all times  | Releases via this pathway may continue for up to 30 days provided within 8 hours samples are continuously collected with auxiliary sampling equipment as required by Table 2. |
| Particulate Sampler Cartridge  | 1                         | At all times  | Releases via this pathway may continue for up to 30 days provided within 8 hours samples are continuously collected with auxiliary sampling equipment as required by Table 2. |
| Duct Flow Monitors   | 1                         | At all times  | Releases via the pathway may continue for up to 30 days provided the flow rate is estimated at least once every 4 hours.  |
| Sample Flow Instruments  | 1                         | At all times  | Releases via the pathway may continue for up to 30 days provided the flow rate is estimated at least once every 4 hours.  |

**Notes:**

- # - Indicates number of channels required per operating recombiner train.
- \* - Provides automatic termination of off-gas treatment system releases.
- \*\* - Provides Control Room indication prior to exceeding 10CFR Part 20 release limits.

Table 3 Radioactive Gaseous Effluent Monitoring Instrumentation (cond'g)

|  |                          |
|--|--------------------------|
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**1.0 RECORD OF REVISION**

| <u>Revision No.</u> | <u>Date</u>     | <u>Reason for Revision</u>  |
|---------------------|-----------------|---|
| 1                   | October - 2000  | <p>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.</p> <p>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<sub>i</sub> values to 10 times the concentration values of 10CFR20.1001-20.2402, Table 2, Column 2.</p> |
| 2                   | November - 2001 | <p>Added clarification of use of computer program LIQDOS to section 2.0. Changed Turbine Building Normal Drain Sump to Turbine Building Normal Waste Sump.</p>  |

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**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  $2 \times 10^{-4}$   $\mu\text{Ci/ml}$  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)<sup>(2)</sup> 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.

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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.

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

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 ( $\mu\text{Ci/ml}$ ).

$$C_t = \frac{F}{f \sum_i \frac{S_i}{\text{MPC}_i}} \quad 2.1-2$$

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);

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and

$MPC_i =$  The liquid effluent radioactivity concentration limit for radionuclide  $i$  ( $\mu\text{Ci/ml}$ ) 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 ( $\mu\text{Ci/ml}$ ).

$$C_m = C_t - (C_t S_H) \quad 2.1-3$$

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).

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

where

$E =$  The detection efficiency of the monitor ( $\mu\text{Ci/cc/cps}$ ) 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.

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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.

$$S_i = \frac{A_i}{\sum A_i} \quad 2.1-5$$

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 ( $\mu\text{Ci/ml}$ ).

$$C_d = \frac{1}{\sum_i \frac{S_i}{\text{MPC}_i}} \quad 2.1-6$$

where

$\text{MPC}_i$  = The liquid effluent radioactivity concentration limit for radionuclide  $i$  ( $\mu\text{Ci/ml}$ ) from Table 1.

- C. Determine  $C_m$ , the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) released into the discharge canal ( $\mu\text{Ci/ml}$ ).

$$C_m = C_d - (C_d S_H) \quad 2.1-7$$

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).

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

where

$E$  = The detection efficiency of the monitor ( $\mu\text{Ci/cc/cps}$ ) from Plant Chemistry Surveillance procedures.

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- 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.

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

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 ( $\mu\text{Ci/ml}$ ).

$$C_t = \frac{1}{\sum_i \frac{S_i}{\text{MPC}_i}} \quad 2.1-10$$

where

$\text{MPC}_i$  = The liquid effluent radioactivity concentration limit for radionuclide  $i$  ( $\mu\text{Ci/ml}$ ) from Table 1.



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- C. Determine  $C_m$ , the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) in the service water prior to dilution ( $\mu\text{Ci/ml}$ ).

$$C_m = C_t - (C_t S_H) \quad 2.1-11$$

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)).

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

where

$E$  = The detection efficiency of the monitor ( $\mu\text{Ci/cc/cps}$ ) 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.

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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.

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

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 ( $\mu\text{Ci/ml}$ ).

$$C_t = \frac{1}{\sum_i \frac{S_i}{\text{MPC}_i}} \quad 2.1-14$$

$\text{MPC}_i$  = The liquid effluent radioactivity concentration limit for radionuclide  $i$  ( $\mu\text{Ci/ml}$ ) from Table 1.

- C. Determine  $C_m$ , the maximum acceptable total radioactivity concentration of the radionuclides (minus tritium) in the TBNWS prior to dilution ( $\mu\text{Ci/ml}$ ).

$$C_m = C_t - (C_t S_H) \quad 2.1-15$$

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).

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

where

$E$  = The detection efficiency of the monitor ( $\mu\text{Ci/cc/cps}$ ) 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.

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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.

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**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:

$$\text{Conc}_i = \frac{C_i R}{\text{MDF}} \quad 2.2-1$$

where

$\text{Conc}_i$  = concentration of radionuclide i at the unrestricted area, ( $\mu\text{Ci/ml}$ );

$C_i$  = concentration of radionuclide i in the potential batch release, ( $\mu\text{Ci/ml}$ );

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

$\text{MDF}$  = 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.

$$\sum_i \frac{\text{Conc}_i}{\text{MPC}_i} \leq 1 \quad 2.2-2$$

where

$\text{MPC}_i$  = maximum concentration of radionuclide i from Table 1, ( $\mu\text{Ci/ml}$ ).

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### 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 calendar 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 batch release. The dilution factor is determined by:

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

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:

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

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, ( $\mu$ Ci/ml);

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$A_{ij}$  = 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  $\mu\text{Ci/ml}$ );

$F_k$  = 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:

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

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, <sup>(5)</sup> (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). <sup>(6)</sup>

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### 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.<sup>(7)</sup> 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.<sup>(8)</sup>

### 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.

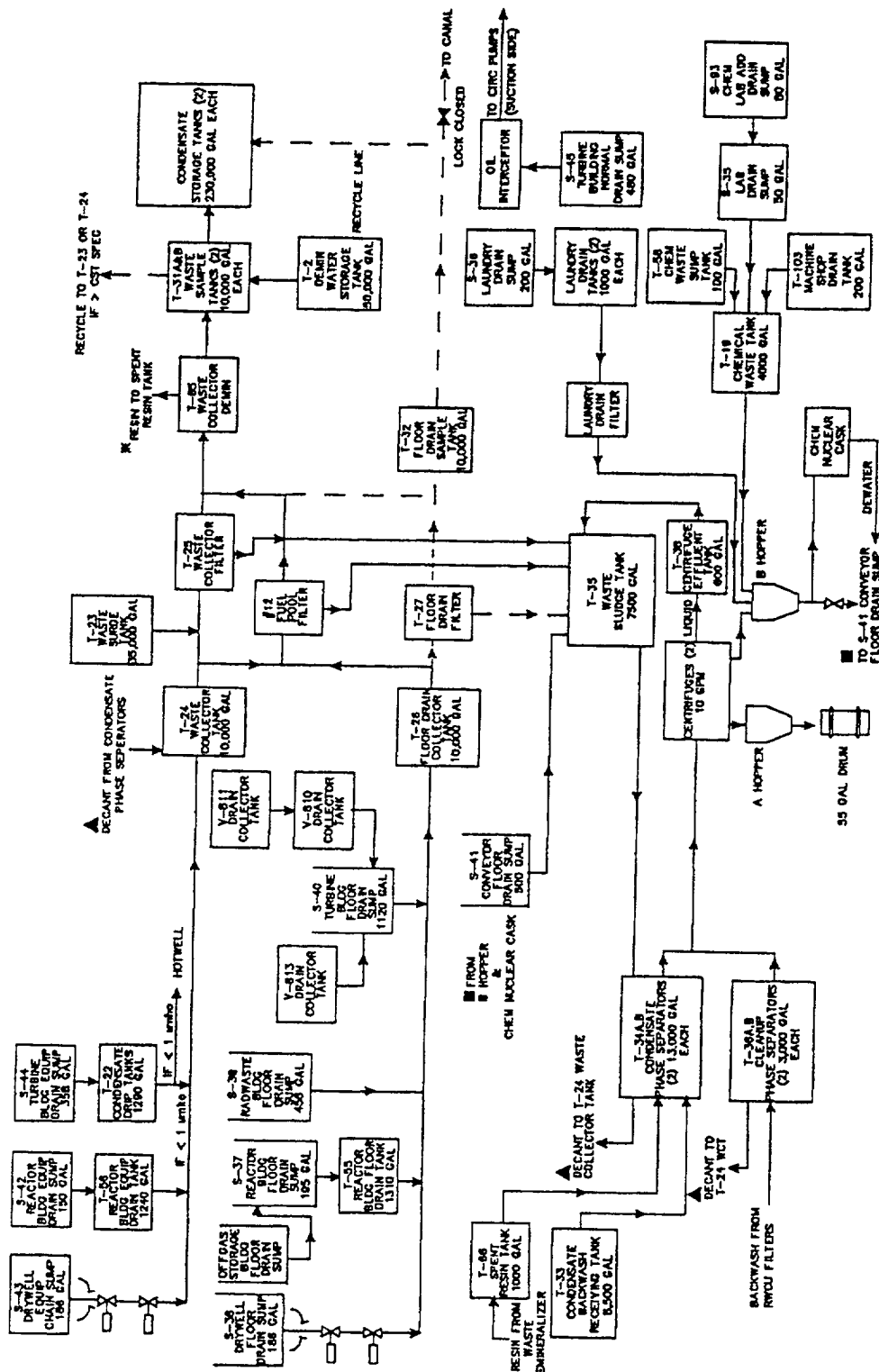
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## 2.4 References

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



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Table 1 Liquid Source Terms

| Radionuclide   | Radioactivity $A_i$<br>Ci/yr* | $MPC_i$<br>$\mu\text{Ci/ml}^{**}$ |
|----------------|-------------------------------|-----------------------------------|
| 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<br>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.

|  |                                     |               |
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Table 2 A<sub>ij</sub> Values for the Monticello Nuclear Generating Plant (mrem/hr per  $\mu$ Ci/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 |

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Table 2 A<sub>ij</sub> Values for the Monticello Nuclear Generating Plant (mrem/hr per  $\mu$ Ci/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 |

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Table 2 A<sub>ij</sub> 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 |

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| Reviewed By: <i>M. Jones</i>                  |                       |
| OC Final Review Meeting: <i>2293-F</i>        | Date: <i>11/15/01</i> |
| Approved By Plant Manager: <i>[Signature]</i> | Date: <i>11/17/01</i> |

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**1.0 RECORD OF REVISION**

| <u>Revision No.</u> | <u>Date</u>     | <u>Reason for Revision</u>  |
|---------------------|-----------------|---|
| 1                   | December - 1998 | Changed word "waste" to "effluent" in section 1.0, changed 1st sentence in section 2.0 to exact wording in T.S., added section 3.0 to reference section 1.0 word change to LAR 39.  |
| 2                   | October - 2000  | <p>Moved previous ODCM-03.01 (GASEOUS EFFLUENTS) into this section and renamed this section "GASEOUS EFFLUENTS CALCULATIONS" to facilitate moving the Radiological Effluents Tech Specs to the ODCM.</p> <p>Moved associated figures and tables into this section to make the section easier to use. Removed references to the unused MIDAS System. Revised references to the X/Q and D/Q values now located in Appendix A.</p> |
| 3                   | November - 2001 | Replaced maximum acceptable flow rate in equation 2.1-9 (85.5 cfm) to the effluent flowrate at the Offgas Pretreatment Monitor.   |



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## 2.0 GASEOUS EFFLUENT CALCULATIONS

This section describes the procedures used by MNGP to:

- A. Determine alarm point settings for gaseous effluent monitors;
- B. Determine that dose rates at the site boundary from noble gases, particulates, and iodines remain below the limits of 10CFR20, and
- C. Determine that the total dose from airborne effluents for the year is within the limits of Appendix I of 10CFR50.

The computations of this section may be done manually, by use of computer programs which implement these algorithms.

### 2.1 Monitor Alarm Setpoint Determination

This procedure determines the effluent monitor alarm setpoint that indicates if the dose rate at or beyond the site boundary due to noble gas radionuclides in the gaseous effluent released from the site exceeds 500 mrem/year to the whole body or exceeds 3000 mrem/year to the skin. Accident monitors are set to limit effluent releases to a small fraction of the limits specified in 10CFR100. In addition this section calculates the maximum activity permitted in each off-gas storage tank.

Monitor high alarm or isolation setpoints are established in one of the following ways:

1. Monthly calculation of setpoints using the methodology of Section 2.1.1 for noble gas nuclides in releases during the previous month.
2. Prior to each containment purge, recalculation of the setpoint using the methodology of Section 2.1.1 based on the sample taken prior to purging.

#### 2.1.1 Effluent Monitors

Monitor alarm setpoints are determined to assure compliance with 10CFR 20. The setpoints indicate that the dose rate at or beyond the site boundary due to noble gas radionuclides in the gaseous effluent released from the site exceeds 500 mrem/year to the whole body or exceeds 3000 mrem/year to the skin.

Monitor alarm setpoints are calculated for the Reactor Building Ventilation Plenum Noble Gas monitors and the Stack Noble Gas monitors once per month. These calculations are based on the noble gas isotopes in releases made during the previous month. The calculations are performed by the DOSGAS computer program.

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In addition, prior to containment purging, the monitor setpoint for the monitor release point is recalculated. This calculation is performed by the DWCAL computer program. The monitor setpoint is determined as follows:

1. If no detectable noble gas activity is found in the purge sample, the values used as the basis for the alarm point setting are from the column, "Drywell purging" in Table 1, Gaseous Source Terms.
2. If any calculated setpoint is less than the existing monitor setpoint, the setpoint is reduced to the new value.
3. 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.
4. The setpoint during purging may not be increased above the setpoint determined for continuous releases, however.

Except for containment inerting and deinerting, all containment purging and venting is done via the standby gas treatment system and plant stack. Containment inerting and deinerting releases are made via the Reactor Building vent. The small amount of containment atmosphere released by the containment sampling system on a continuous basis is not considered a venting operation.

#### A. Reactor Building Vent Alarm Setpoint

The following method applies to gaseous releases via the Reactor Building vent when determining the high-high alarm setpoint for the Reactor Building Vent Noble Gas Monitor. This method is applied to both continuous releases and batch releases (containment inerting and deinerting).

1. Determine the "mix" (noble gas radionuclides and composition) of the gaseous effluent.
  - a. Determine the gaseous source terms that are representative of the "mix" of the gaseous effluent. Gaseous source terms are the total curies of each noble gas released during the previous month or a representative analysis of the gaseous effluent. Table 1 source terms may be used if the Reactor Building releases for the previous month were below the lower limits of detection (LLD), or, in the case of inerting and deinerting releases, no detectable activity was found in the grab sample taken prior to purging.

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- b. Determine  $S_i$ , the fraction of the total radioactivity in the gaseous effluent comprised by noble gas radionuclide "i", for each individual noble gas radionuclide in the gaseous effluent.

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

where

$A_i$  = The radioactivity of noble gas radionuclide "i" in the gaseous effluent.

2. Determine  $Q_t$ , the maximum acceptable total release rate of all noble gas radionuclides in the gaseous effluent ( $\mu\text{Ci}/\text{sec}$ ), based upon the whole body exposure limit (500 mrem/yr).

$$Q_t = \frac{500}{(\chi/Q)_v \sum_i K_i S_i} \quad 2.1-2$$

where

$(\chi/Q)_v$  = The highest calculated average relative concentration of effluents released via the Reactor Building vent for any area at or beyond the site boundary for all sectors ( $\text{sec}/\text{M}^3$ ) from Appendix A, Table 3. For purge releases, substitute the value obtained from Chemistry Manual Procedure I.6.07 (ATMOSPHERIC DISPERSION DETERMINATION).

$K_i$  = The total whole body dose factor due to gamma emissions from noble gas radionuclide "i" ( $\text{mrem}/\text{year}/\mu\text{Ci}/\text{m}^3$ ) from Table 2.

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3. Determine  $Q_t$  based upon the skin exposure limit (3000 mrem/yr).

$$Q_t = \frac{3000}{(\chi/Q) \sum_{v_i} (L_i + 1.1 M_i) S_i} \quad 2.1-3$$

where

$L_i + 1.1 M_i$  = the total skin dose factor due to emissions from noble gas radionuclide "i" (mrem/year/ $\mu\text{Ci}/\text{m}^3$ ) from Table 2.

4. Determine HHSP (the monitor high-high alarm setpoint above background (net  $\mu\text{Ci}/\text{sec}$ )).

**NOTE:** Use the lower of the  $Q_t$  values obtained in Sections 2.1.1.A.2. and 2.1.1.A.3.

$$\text{HHSP} = 0.50 Q_t \quad 2.1-4$$

0.50 = Fraction of the total radioactivity from the site via the monitored release point to ensure that the site boundary limit is not exceeded due to simultaneous releases from several release points.

#### B. Stack Isolation Setpoint

The following method applies to gaseous releases via the Stack when determining the high-high alarm setpoint for the Stack Gas Monitor which initiates isolation of Stack releases. The method is applied to both continuous releases and batch releases (containment purges). Mechanical vacuum pump releases (relatively insignificant) will be controlled using the continuous setpoint.

1. Determine the "mix" (noble gases and composition) of the gaseous effluent.
  - a. Determine the gaseous source terms that are representative of the "mix" of the gaseous effluent. Gaseous source terms are the total curies of each noble gas released during the previous month or a representative analysis of the gaseous effluent. Table 1 source terms may be used if the Stack releases for the previous month were below the lower limits of detection (LLD).

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- b. Determine  $S_i$ , the fraction of the total radioactivity in the gaseous effluent comprised by noble gas radionuclide "i", for each individual noble gas radionuclide in the gaseous effluent.

$$S_i = \frac{A_i}{\sum_i A_i} \quad 2.1-5$$

where

$A_i$  = The radioactivity of noble gas radionuclide "i" in the gaseous effluent.

2. Determine  $Q_t$ , the maximum acceptable total release rate of all noble gas radionuclides in the gaseous effluent ( $\mu\text{Ci}/\text{sec}$ ), based upon the whole body exposure limit (500 mrem/yr).

$$Q_t = \sum_i V_i S_i \quad 2.1-6$$

**NOTE:** For short-term batch releases (equal to or less than 500 hrs/yr) via drywell purging, substitute  $v_i$  for  $V_i$  in Equation 2.1-6.

where

$V_i$  = The constant for long-term releases (greater than 500 hr/yr) for noble gas radionuclide "i" accounting for the gamma radiation from the elevated finite plume (mrem/year/ $\mu\text{Ci}/\text{sec}$ ) from Table 2.

$v_i$  = The constant for short-term releases (equal to or less than 500hr/yr) for noble gas radionuclide "i" accounting for the gamma radiation from the elevated finite plume (mrem/yr/ $\mu\text{Ci}/\text{sec}$ ) from Table 2.

3. Determine  $Q_t$  based upon the skin exposure limit (3000 mrem/yr).

$$Q_t = \sum_i \frac{3000}{(L_i (\chi/Q)_s + 1.1B_i)} S_i \quad 2.1-7$$

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**NOTE:** For short-term batch releases (equal to or less than 500 hours per year) via drywell purging, use the short-term  $(\chi/q)_s$  value and substitute  $b_i$  for  $B_i$  in Equation 2.1-7.

where

$L_i(\chi/Q)_s + 1.1B_i =$  The total skin dose constant for long-term releases (greater than 500 hours per year) due to emissions from noble gas radionuclide "i", Table 2, (mrem/year/ $\mu$ Ci/sec);

$L_i(\chi/q)_s + 1.1b_i =$  The total skin dose constant for short-term releases (less than or equal to 500 hours per year) due to emissions from noble gas radionuclide "i", Table 2, (mrem/year/ $\mu$ Ci/sec).

4. Determine HHSP (the monitor high-high alarm setpoint above background ( $\mu$ Ci/sec)).

**NOTE:** Use the lower of the  $Q_t$  values obtained in sections 2.1.1.B.2. and 2.1.1.B.3.

$$\text{HHSP} = 0.50 Q_t \quad 2.1-8$$

0.50 = Fraction of the total radioactivity from the site via the monitored release point to ensure that the site boundary limit is not exceeded due to simultaneous releases from several release points.

### 2.1.2 Accident Monitors

The gross radioactivity in noble gases removed from the main condenser by means of steam jet air ejectors as measured prior to entering the treatment, adsorption, and delay systems **SHALL** be limited by an alarm setpoint for the Offgas Monitor.

This procedure determines the monitor alarm setpoint that indicates if the potential body accident dose to an individual at or beyond the site boundary due to noble gas radionuclides in the gaseous effluent released from the site exceeds a small fraction of the limits specified in 10CFR100 in the event this effluent, including the radioactivity accumulated in the treatment system, is inadvertently discharged directly to the environment without treatment. This calculation is performed by the OFFGAS computer program on a routine or an as needed basis. Offgas flow is automatically terminated when this setpoint is reached.

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A. Maximum Release Rate

Determine  $Q_t$ , the maximum acceptable total release rate in  $\mu\text{Ci}/\text{sec}$  of all noble gas radionuclides in the gaseous effluent at the Offgas Monitor after a 5-minute decay, based on the maximum acceptable total release rate of  $2.60\text{E}5 \mu\text{Ci}/\text{sec}$  after a 30-minute decay.

1. Determine the offgas mixture of the gaseous effluent. The offgas mixture is the fraction of the offgas noble gas radioactivity caused by each recoil diffusion, and equilibrium component. The offgas mixture is determined at least once per month.
2. Determine  $Q_t$  based on the offgas mixture using Table 3. This table was prepared using a variation of the EBARR computer code.

B. Maximum Concentration

Determine  $C_t$ , the maximum acceptable total radioactivity concentration of all noble gas radionuclides in the gaseous effluent ( $\mu\text{Ci}/\text{cc}$ ).

$$C_t = 2.12 \text{ E-}03 \frac{Q_t}{f} \quad 2.1-9$$

where

f = The effluent flowrate at the Offgas Pretreatment Monitor (cfm);

C. Monitor Reading

Determine C.R., the calculated monitor reading above background attributed to the noble gas radionuclides (mR/hr).

$$\text{C.R.} = \frac{C_t}{E} \quad 2.1-10$$

where

E = The detection efficiency of the monitor for noble gas radionuclides represented in main condenser offgas ( $\mu\text{Ci}/\text{cc}/\text{mR}/\text{hr}$ ) from Plant Chemistry Surveillance procedures.

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D. Monitor High High Setpoint

The monitor high-high alarm setpoint above background (mr/hr) should be set at or below the C.R. value.

2.1.3 Offgas Storage Tank Maximum Activity

The maximum activity in each storage tank is limited to less than 22,000 curies of noble gas (considered as dose equivalent Xe-133) after 12 hours of holdup. To verify that this limit is not exceeded, Table 3 is used.

The gross radioactivity of noble gases from the main condenser air ejector is determined by isotopic analysis monthly and whenever a significant increase in offgas activity is noted. Analysis of this data is used to determine the primary mode of fission product release from the fuel (recoil, equilibrium, or diffusion) and the gross release rate. This information combined with the condenser air leakage rate (cfm) and the air ejector monitor release rate is used to confirm that the maximum tank contents limit is not exceeded. This calculation is performed by the OFFGAS computer program on a routine or as needed basis.

Table 3 is entered with the offgas mixture (fraction recoil, diffusion, and equilibrium rounded to one decimal place) and the air leakage rate (in cfm). The resulting tank activity is multiplied by the current total release rate after a 30 minute decay ( $\mu\text{Ci}/\text{sec}$ ) and divided by the maximum permitted air ejector release rate of 260,000  $\mu\text{Ci}/\text{sec}$ . Linear interpolation of air leakage is used.

As noted earlier, Table 3 is derived from the EBARR computer program described in Section 2.4. It is extremely unlikely that the maximum tank activity limit will be exceeded.



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**2.2 Gaseous Effluent Dose Rate - Compliance With 10CFR20**

Dose rates resulting from the release of noble gases, and from radioiodines and particulates must be calculated to show compliance with 10CFR20. The dose rate limits of 10CFR20 are conservatively applied on an instantaneous basis at the hypothetical worst case location.

**2.2.1 Noble Gases**

The dose rate in unrestricted areas resulting from noble gas effluents is limited to 500 mrem/yr to the total body and 3000 mrem/yr to the skin. The setpoint determinations discussed in the previous section are based on the dose rate calculation method presented in NUREG-0133<sup>(4)</sup>. This represents a backward solution to the limiting dose rate equations in NUREG-0133. Setting alarm trip setpoints in this manner will ensure that the limits of 10CFR20 are met for noble gas releases. Therefore, no routine dose rate calculations for noble gases will be needed to show compliance with this part. Routine calculations are made for dose rates from noble gas releases to show compliance with 10CFR50, Appendix I by performing the DOSGAS computer program.

**2.2.2 Radioiodine and Radioactive Particulates and Other Radionuclides**

The dose rate in unrestricted areas resulting from the release of radioiodines and particulates with half lives greater than 8 days is limited by 10CFR20 to 1500 mrem/yr to any organ. The calculation of dose rate from radioiodines and particulates is performed for drywell purges prior to the release and weekly for all releases. This calculation is performed by the DWCAL computer program for drywell purges and 1/week by the IPART computer program for all releases. The calculations are based on the results of analyses obtained pursuant to Surveillance Requirement 3.1.4.B. To show compliance with 10CFR20, Equation 2.2-1 will be evaluated for I-131, I-133, tritium, and radioactive particulates with half lives greater than eight days.

$$\sum_i P_i [(\chi/Q_v) Q_{iv} + (\chi/Q_s) Q_{is}] < 1500 \text{ mrem/yr} \quad 2.2-1$$

where

$P_i$  = child critical organ dose parameter for radionuclide i for the inhalation pathway, mrem/yr per  $\mu\text{Ci}/\text{m}^3$ ; (Table 4)

$(\chi/Q)_v$  = annual average relative concentration for long-term release from the Reactor Building vent at the critical location,  $\text{sec}/\text{m}^3$  (Appendix A, Table 3);

$(\chi/Q)_s$  = annual average relative concentration for long-term releases from the offgas stack at the critical location,  $\text{sec}/\text{m}^3$  (Appendix A, Table 6);

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$Q_{iv}$  = the release rate of radionuclide i from the Reactor Building vent for the week of interest,  $\mu\text{Ci}/\text{sec}$ ;

$Q_{is}$  = the release rate of radionuclide i from the offgas stack for the week of interest,  $\mu\text{Ci}/\text{sec}$ .

The  $\chi/Q$  values presented in Appendix A, Tables 3 and 6 have been calculated using the USNRC computer code "XOQDOQ"<sup>(5)</sup>. Dose rate calculations using Equation 2.2-1 are made once per week. The source terms  $Q_{iv}$  and  $Q_{is}$  are determined from the results of analysis of weekly stack and Reactor Building particulate filters and charcoal cartridges. These source terms include all gaseous releases from MNGP. They are recorded and reported as the total dose for compliance with 10CFR20.

Radioiodines and particulates may be released from both the offgas stack and the Reactor Building vent. As specified in NUREG-0133, the critical receptor location is identified based on the Reactor Building vent  $\chi/Q$ .

A component of the total stack or vent source term may be due to short term releases occurring as a result of containment drywell purging. Dose rate calculations are made on this component separately to further assure compliance with 10CFR 20 prior to release. The calculated dose rate is used only to determine whether or not the drywell can be purged. All dose rates from drywell purges will be accounted for and reported through the weekly calculations discussed above. Release rates are determined from the results of analyses of samples from the drywell.

The term  $Q_{is}$  for the calculation of drywell purge dose rate is determined by multiplying the concentration of each nuclide in the drywell by the rate of release. Credit will be taken for the expected reduction in radionuclide concentration due to use of the standby gas treatment system. Equation 2.2-2 is used to calculate purge dose rates. Only one source term is used depending on the release point (stack or Reactor Building vent). Short term values of  $\chi/q$  from Appendix A, Table 9 or Table 12 are used in the purge dose rate calculation. the limiting dose rate limit for each purge is determined using:

$$BL = 1500 - (D_{cv} + D_{cs} - D_{dw}) \quad 2.2-2$$

where

BL = limiting dose rate for the batch, mrem/yr;

$D_{cv}$  = previous week's dose rate from Reactor Building continuous and batch releases, mrem/yr;

$D_{cs}$  = previous week's dose rate from offgas stack continuous and batch releases, mrem/yr;

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$D_{dw}$  = previous week's total dose rate from drywell purge releases, mrem/yr, for the purge release point.

Although mechanical vacuum pump releases are batch mode, they cannot be sampled prior to release. For this reason, no prerelease dose rate calculations can be made from this source. Experience has shown mechanical vacuum pump release to be well within 10CFR20 limits.

### 2.2.3 Critical Receptor Identification

As stated in 5.2.1 of NUREG-0133, when the critical receptor is different for stack and vent releases, the controlling location for vent releases should be used. For this reason, the Reactor Building vent dispersion parameters are used to identify the critical receptor. The real time atmospheric dispersion factor ( $\chi/Q$ ) is calculated by performing the MIDAS XP computer program IAW MNGP Chemistry Procedure I.06.07. As discussed previously, weekly and batch dose rate calculations are performed for the critical boundary location. The critical boundary location is based on reactor vent long term  $\chi/Q$  (Appendix A, Table 3) is 0.43 miles in the SSE sector.

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## 2.3 Gaseous Effluents - Compliance With 10CFR50

Doses resulting from the release of noble gases, and radioiodines and particulates must be calculated to show compliance with Appendix I of 10CFR50. The calculations are performed monthly for all gaseous effluents. Calculations of the doses received due to the release of noble gases is performed by the DOSGAS computer program. Similarly the dose received due to the release of radioiodines and particulates is calculated by the DOSPIT computer program. These two programs are performed monthly or as required.

This section describes the methods and equations used at MNGP to perform the dose evaluation using manual methods based on historical meteorological dispersion parameters.

### 2.3.1 Noble Gases

The air dose in unrestricted areas at MNGP is limited to:

A. for any calendar quarter:

$$D_{\gamma} \leq 5 \text{ mrad due to gamma radiation; and}$$

$$D_{\beta} \leq 10 \text{ mrad due to beta radiation; and}$$

B. for any calendar year:

$$D_{\gamma} \leq 10 \text{ mrad due to gamma radiation; and}$$

$$D_{\beta} \leq 20 \text{ mrad due to beta radiation.}$$

Air doses may be calculated using historical meteorological data using the highest normalized concentration statistics as the best estimator of the atmospheric dispersion.

A. Air Dose Based on Historical Meteorology

The limiting air dose, D, based on historical meteorology is based on the critical receptor in the unrestricted area. For air doses the critical receptor is described by the off-site location with the highest long term annual average relative concentration ( $\chi/Q$ ) at or beyond the restricted area boundary. For short-term vent releases (less than 500 hours per year), the location with the highest short-term average relative concentration ( $\chi/q$ ) is chosen. The critical receptor is described in section 2.3.5.

For gamma radiation, the air dose is given by:

$$D_{\gamma} = 3.17 \times 10^{-8} \sum_i (M_i [(\chi/Q)_v Q_{iv} + (\chi/q)_v q_{iv}] + B_i Q_{is} + b_i q_{is})$$

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The historical meteorological data base is the basis for the method described in the original MNGP ODCM.

For beta radiation, the air dose is:

$$D_{\beta} = 3.17 \times 10^{-8} \sum_i N_i [(\chi/Q)_v Q_{iv} + (\chi/q)_v q_{iv} + (\chi/Q)_s Q_{is} + (\chi/q)_s q_{is}]$$

2.3-2

where

- $M_i$  = The air dose factor due to gamma emission for each identified noble gas radionuclide  $i$ , mrad/yr per  $\mu\text{Ci}/\text{m}^3$ ; (Table 5)
- $N_i$  = the air dose factor due to beta emissions for each identified noble gas radionuclide  $i$ , mrad/yr per  $\mu\text{Ci}/\text{m}^3$ ; (Table 5)
- $(\chi/Q)_v$  = the annual average relative concentration for areas at or beyond the site boundary for long-term Reactor Building vent releases (greater than 500 hr/yr),  $\text{sec}/\text{m}^3$ , (Appendix A, Table 3);
- $(\chi/q)_v$  = the relative concentration for areas at or beyond the site boundary for short-term Reactor Building vent releases (equal to or less than 500 hr/yr),  $\text{sec}/\text{m}^3$ , (Appendix A, Table 12);
- $(\chi/Q)_s$  = the annual average relative concentration for areas at or beyond the site boundary for long-term offgas stack releases (greater than 500 hr/yr),  $\text{sec}/\text{m}^3$  (Appendix A, Table 6);
- $(\chi/q)_s$  = the relative concentration for areas at or beyond the site boundary for short-term offgas stack releases (equal to or less than 500 hr/yr),  $\text{sec}/\text{m}^3$  (Appendix A, Table 9);
- $q_{is}$  = the average release of the noble gas radionuclide  $i$  in gaseous effluents for short-term offgas stack releases (equal to or less than 500 hr/yr),  $\mu\text{Ci}$ ;
- $q_{iv}$  = the average total release of the noble gas radionuclide  $i$  in gaseous effluents for short-term Reactor Building vent releases (equal to or less than 500 hr/yr),  $\mu\text{Ci}$ ;
- $Q_{is}$  = the total release of noble gas radionuclide  $i$  in gaseous releases for long-term offgas stack releases (greater than 500 hr/yr),  $\mu\text{Ci}$ ;

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$Q_{iv}$  = the total release of noble gas radionuclide  $i$  in gaseous effluents for long-term Reactor Building vent releases (greater than 500 hr/yr),  $\mu\text{Ci}$ ;

$B_i$  = the constant for long-term releases (greater than 500 hr/yr) for each identified noble gas radionuclide  $i$  accounting for the gamma radiation from the elevated finite plume, mrad/yr per  $\mu\text{Ci}/\text{sec}$  (Table 6);

$b_i$  = the constant for short-term releases (less than or equal to 500hr/yr) for each identified noble gas radionuclide  $i$  accounting for the gamma radiation from the elevated finite plume, mrad/yr per  $\mu\text{Ci}/\text{sec}$  (Table 6);

$3.17 \times 10^8$  = the inverse of the number of seconds in a year.

Noble gases are continuously released from the Reactor Building vent and the plant stack. These long-term releases rates are determined from the continuous noble gas monitor readings and periodic radionuclide analyses. There are infrequent containment purges from either release point. To separate the short-term release from the long term release (the continuous monitor records both), the drywell source term should be subtracted from the total source term whenever a purge release occurs. Periodic radionuclide analysis of main condenser offgas and radionuclide analysis of each purge prior to release are used in conjunction with the total activity measured by the monitor to quantify individual noble gas nuclides released.

Long-term and short-term  $\chi/Q$ 's are given in Appendix A for both the Reactor Building vent and the plant stack. Short-term  $\chi/q$ 's were calculated using the USNRC computer code "XOQDOQ" assuming 144 hours per year drywell purge. Values of  $M$  and  $N$  were calculated using the methodology presented in NUREG-0133 and are given in Table 5. Table 6 presents values of  $B_i$  and  $b_i$  calculated using the USNRC computer code "RABFIN." This code was also used to calculate values of  $V_i$  presented in section 1.0. Values of  $v_i$  were calculated by multiplying  $V_i$  by the ratio of  $b_i$  to  $B_i$ . The  $v_i$ ,  $iB_i$ , and  $b_i$  values of Table 6 are the maximum values for the site boundaries location. This location, 0.51 mi SSE, is different than the critical site boundary location based upon the Reactor Building vent  $\chi/Q$ .

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### 2.3.2 Radioiodine, Particulates, and Other Radionuclides

The dose,  $D_{aj}$ , 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:

$$D_{aj} \leq 7.5 \text{ mrem for any calendar quarter}$$

$$D_{aj} \leq 15 \text{ mrem for any calendar year}$$

These limits apply to the receptor location where the combination of existing pathways and age groups indicates the maximum exposure.

#### A. Dose from Radioiodines and Particulates Based on Historical Meteorology

The worst case dose to an individual from I-131, tritium and radioactive particulates with half-lives greater than eight days in gaseous effluents released to unrestricted areas is determined by the following expressions:

$$D_{aj} = 3.17 \times 10^{-8} \sum_{pi} \sum R_{iapj} [W_v Q_{iv} + W_v q_{iv} + W_s Q_{is} + W_s q_{is}] \quad 2.3-3$$

where

$Q_{is}$  = release of radionuclide i for long-term offgas stack releases (greater than 500 hr/yr),  $\mu\text{Ci}$ ;

$Q_{iv}$  = release of radionuclide i for long-term Reactor Building vent releases (greater than 500 hr/yr),  $\mu\text{Ci}$ ;

$q_{is}$  = release of radionuclide i for short-term offgas stack purge releases (equal to or less than 500 hr/yr);  $\mu\text{Ci}$ ;

$q_{iv}$  = release of radionuclide i for short-term Reactor Building vent purge releases (equal to or less than 500 hr/yr);  $\mu\text{Ci}$ ;

$W_s$  = the dispersion parameter for estimating the dose to an individual at the controlling location for long-term offgas stack releases (greater than 500 hr/yr),  $\text{sec}/\text{m}^3$  or  $\text{m}^{-2}$ ;

$W_v$  = the dispersion parameter for estimating the dose to an individual at the controlling location for long-term Reactor Building vent releases (greater than 500 hr/yr),  $\text{sec}/\text{m}^3$  or  $\text{m}^{-2}$ ;

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$W_s$  = the dispersion parameter for estimating the dose to an individual at the controlling location for short-term offgas stack releases (equal to or less than 500 hr/yr),  $\text{sec}/\text{m}^3$  or  $\text{m}^{-2}$ ;

$W_v$  = the dispersion parameter for estimating the dose to an individual at the controlling location for short-term Reactor Building vent releases (equal to or less than 500 hr/yr),  $\text{sec}/\text{m}^3$  or  $\text{m}^{-2}$

$3.17 \times 10^{-8}$  = the inverse of the number of seconds in a year.

$R_{iapj}$  = the dose factor for each identified radionuclide i, pathway p, age group a, and organ j,  $\text{m}^2 \text{mrem}/\text{yr}$  per  $\mu\text{Ci}/\text{sec}$  or  $\text{mrem}/\text{yr}$  per  $\mu\text{Ci}/\text{m}^3$ .

The above equation is applied to each combination of age group and organ. Values of  $R_{iapj}$  have been calculated using the methodology given in NUREG-0133 and are given in Tables 7 through 25. The equation is applied to a controlling location which will be one of the following:

- A. residence,
- B. vegetable garden,
- C. milk animal.

The selection of the actual receptor is discussed in section 2.3.5. The W values are in terms of  $\chi/Q$  ( $\text{sec}/\text{m}^3$ ) for the inhalation pathways and for tritium and in terms of  $D/Q$  ( $\text{m}^{-2}$ ) for all other pathways.

Section 2.5.2 contains the methodology for calculating  $R_{iapj}$  values. This method will be used to compute dose factors for nuclides not tabulated in Tables 7 through 25 if they are encountered.

### 2.3.3 Cumulation of Doses

Doses calculated monthly are summed for comparison with quarterly and annual limits. The monthly results are added to the doses cumulated from the other months in the quarter of interest and in the year of interest and compared to the limits given in section 2.3.1 and 2.3.2. This summation is performed by the DOSGAS and the DOSPIT computer programs for doses from exposures due to noble gas, and radioiodine and particulates respectively. If these limits are exceeded, a Special Report will be submitted to the USNRC. If twice the limits are exceeded, a Special Report showing compliance with 40CFR190<sup>(9)</sup> will be submitted.



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2.3.4 Projection of Doses

Projection of doses is not necessary. The ODCM requires the offgas holdup system to be operated at all times.

2.3.5 Critical Receptor Identification

The critical receptors for compliance with 10CFR50, Appendix I will be identified. For the noble gas specification the critical location is based on the external dose pathway only. This location is the off-site location with the highest long-term Reactor Building vent  $\chi/Q$  and is selected using the  $\chi/Q$  values given in Appendix A, Table 4. The critical receptor location is used for showing compliance with 10CFR20 and remains the same unless meteorological data is re-evaluated or the site boundary changes.

The critical location for the radioiodine and particulate pathway is selected once per year. This selection follows the annual land use census performed within 5 miles of the MNGP. Each of the following locations is evaluated as a potential critical receptor before implementing the effluent technical specifications:

- A. Residences in each sector.
- B. Vegetable garden producing leafy green vegetables.
- C. All identified milk animal locations.

The critical receptor is selected based on this evaluation.

Following the annual survey, doses are calculated using Equation 2.3-3 for all newly identified receptors and those receptors whose characteristics have changed significantly. The calculation includes appropriate information shown to exist at each location. The dispersion parameters given in this manual should be employed. The total releases reported for the previous calendar year should be used as the source term.

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## 2.4 Summary of EBARR Computer Program

The basic task performed by EBARR is to predict the offgas composition and activity at various stages of waste gas treatment and at the time of release (Table 26). The basic data supplied to EBARR consists of the release rate, in  $\mu\text{Ci}/\text{sec}$  measured at the SJAE, of six readily measurable fission product noble gases: Xe-133, Xe-135, Kr-85M, Kr-88, Kr-87, and Xe-138. There are nine other noble gases of interest from a radioactive effluent point of view. They are: Kr-90, Xe-139, Kr-89, Xe-137, Xe-135m, Kr-83m, Xe-133m, Xe-131m, and Kr-85. Many of these nine gases are not directly measurable in the presence of the others. By establishing the offgas release mode from the six measured release rates, EBARR computes the release rates of the other nine gases known to be present.

The first step performed by EBARR is to correct the release rates of the six measured noble gases for decay during their transit from the reactor vessel to the SJAE:

$$A_i(0) = A_i(t_{\text{dly}}) e^{\lambda_i t_{\text{dly}}} \quad 2.4-1$$

where

$A_i(t)$  = release rate of noble gas  $i$  at the time  $t$  after leaving reactor,  $\mu\text{Ci}/\text{sec}$ ;

$t_{\text{dly}}$  = transit time from reactor to SJAE, sec;

$\lambda_i$  = decay constant of noble gas  $i$ ,  $\text{sec}^{-1}$ .

EBARR then uses a least square fitting routine to determine the values of  $B_1$ ,  $B_2$ , and  $B_3$  giving the best fit to  $A_1(0)$  through  $A_6(0)$  in the equation:

$$\log \left| \frac{A_i}{y_i \lambda_i} \right| = \log \left| B_1 + \frac{B_2}{\sqrt{\lambda_i}} + \frac{B_3}{\lambda_i} \right| \quad 2.4-2$$

where

$y_i$  = fraction of all fissions yielding noble gas  $i$ .

This equation consists of three terms; a recoil release mode term, a diffusion release mode term, and an equilibrium release mode term. This is the standard General Electric offgas distribution model.

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The values of  $B_1$ ,  $B_2$ , and  $B_3$ , are used by EBARR to characterize the offgas release mechanism in terms of percent recoil, percent diffusion, and percent equilibrium type release. This characterization is useful in fuel performance evaluation. The equation for these three fractions are:

$$\% \text{ Recoil} = 100 \times \frac{\sum_{i=1,6} B_1 y_i \lambda_i}{\sum_{i=1,6} (B_1 y_i \lambda_i + B_2 y_i \sqrt{\lambda_i} + B_3 y_i)} \quad 2.4-3$$

$$\% \text{ Diffusion} = 100 \times \frac{\sum_{i=1,6} B_2 y_i \sqrt{\lambda_i}}{\sum_{i=1,6} (B_1 y_i \lambda_i + B_2 y_i \sqrt{\lambda_i} + B_3 y_i)} \quad 2.4-4$$

$$\% \text{ Equilibrium} = 100 \times \frac{\sum_{i=1,6} B_3 y_i}{\sum_{i=1,6} (B_1 y_i \lambda_i + B_2 y_i \sqrt{\lambda_i} + B_3 y_i)} \quad 2.4-5$$

The release rate from the reactor vessel for the nine noble gases not measured is then:

$$A_i(0) = B_1 y_i \lambda_i + B_2 y_i \sqrt{\lambda_i} + B_3 y_i \quad 2.4-6$$

At any time,  $t$ , after leaving the reactor vessel the release rate is:

$$A_i(t) = A_i(0) e^{-\lambda_i t}, \text{ for } i = 3 \text{ through } 14 \quad 2.4-7$$

and

$$A_i(t) = A_i(0) e^{-\lambda_i t} + \frac{\alpha_i \lambda_i A_j(0)}{\lambda_i - \lambda_j} (e^{-\lambda_j t} - e^{-\lambda_i t}), \text{ for } i = 1, 2, \text{ and } 15 \quad 2.4-8$$

where

$\alpha_i$  = fraction of disintegrations of isotope  $j$  producing isotope  $i$ .

Equation (2.4-8) contains an additional factor to account for the decay of Xe-131m to Xe-133, Xe-135m to Xe-135, and Kr-85m to Kr-85. This factor is normally small.

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As shown in Table 26, the plant stack noble gas release consists of three components:

- A. main condenser non-condensibles;
- B. gland exhaust; and
- C. stack dilution air drawn from Reactor and Turbine Buildings.

Source C is considered to be negligible compared to sources A and B. The composition of the gland exhaust release is assumed to be identical to the offgas mixture at the SJAE. Therefore, the stack release rate of isotope *i* is:

$$R_i(t) = A_i(t) + F_{loc}A_i(t_{dly}) \quad 2.4-9$$

where

$F_{loc}$  = fraction of main steam flow diverted to gland seal steam supply and the total noble gas release rate at any time is:

$$R_{tot}(t) = \sum_{i=1, 15} [A_i(t) + F_{loc}A_i(t_{dly})] \quad 2.4-10$$

EBARR also performs a secondary task of computing the compressed offgas storage tank contents in terms of dose equivalent Xe-133. Control 2.4.1.B in ODCM-03.01 limits this quantity to 22,000 Curies 12 hours after placing a tank in storage (when the discharge valve interlock permits the tank to be released).

Prior to reaching the storage tanks (Table 26), the offgas stream is delayed several hours flowing from the recombiners to the compressors via the 42-inch holdup pipe. Offgas reaching the tanks is therefore delayed by:

$$t_{ddly} = t_{dly} + \frac{P_{42}V_{42}}{P_a L} \quad 2.4-11$$

where

- $V_{42}$  = 42-inch pipe volume;
- $P_{42}$  = 42-inch pipe pressure;
- $L$  = total air inleakage, SCFM, (Bleed air and condenser inleakage);
- $P_a$  = atmospheric pressure.

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While a tank is being filled, offgas enters the tank at rate L. The activity of each isotope in the tank,  $C_i$ , is a function of time from the start of filling,  $t_f$ , is computed by EBARR using.

$$C_i(t_f) = \frac{A_i(t_{ddly})}{\lambda_i} (1 - e^{-\lambda_i t_f}) \quad \text{for } i = 3 \text{ to } 14 \quad 2.4-12$$

and

$$C_i(t_f) = \frac{A_i(t_{ddly})}{i} (1 - e^{-\lambda_i t_f}) + \frac{\alpha_i \lambda_i A_j(t_{ddly})}{\lambda_j} \left[ \frac{e^{-\lambda_i t_f} - e^{-\lambda_j t_f}}{\lambda_i - \lambda_j} + 1 \frac{e^{-\lambda_i t_f}}{\lambda_i} \right] \quad \text{for } i = 1, 2, \text{ and } 15 \quad 2.4-13$$

Equation 2.4-13 contains an additional factor to account for the decay of Xe-133m to Xe-133, Xe-135m to Xe-135, and Kr-85m to Kr-85. This factor is normally small.

Pressure builds up in the tank at the rate:

$$p(t_f) = \frac{t_f L P_a}{V_{tk}} \quad 2.4-14$$

where

$V_{tk}$  = volume of storage tank.

When the pressure in the tank reaches the design value,  $P_{max}$ , at  $t_{fill}$ , EBARR assumes the tank is full. Total tank activity, C, and total tank Xe-133 dose equivalent activity, D, is computed at  $t_{rel}$  when the interlock on the tank discharge valve permits the tank to be released after an additional delay of  $t_{intk}$ :

$$t_{fill} = \frac{P_{max} V_{tk}}{P_a L} \quad 2.4-15$$

$$t_{rel} = t_{fill} + t_{intk} \quad 2.4-16$$

$$C_i(t_{rel}) = C_i(t_{fill}) e^{-\lambda_i t_{intk}}, \quad \text{for } i = 3 \text{ through } 14 \quad 2.4-17$$

and

$$C_i(t_{rel}) = (C_i(t_{fill}) e^{-\lambda_i t_{intk}}) + \frac{\alpha_i \lambda_i C_j(t_{fill})}{\lambda_i - \lambda_j} (e^{-\lambda_j t_{intk}} - e^{-\lambda_i t_{intk}}) \quad \text{for } i = 1, 2, \text{ and } 15 \quad 2.4-18$$

$$C(t_{rel}) = \sum_{i=1, 15} C_i(t_{rel}) \quad 2.4-19$$

$$D(t_{rel}) = \frac{\sum_{i=1, 15} C_i(t_{rel}) K_i}{K_i} \quad 2.4-20$$

where

$K_i$  = value of  $K_i$  for Xe-133 ( $i = 1$ ) from Table 5.

The minimum offgas holdup time is:

$$t_{holdup} = t_{ddly} + t_{rel} \quad 2.4-21$$

When the system is operating normally; however, with all five holdup tanks in service, the holdup time is given by:

$$t_{holdup} = t_{ddly} + 4 t_{fill} \quad 2.4-22$$

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## 2.5 Dose Parameters for Radioiodines, Particulates and Tritium

This section contains the methodology which was used to calculate the dose parameters for radioiodines, particulates, and tritium to show compliance with 10CFR20 and Appendix I of 10CFR50 for gaseous effluents. These dose parameters,  $P_i$  and  $R_i$  were calculated using the methodology outlines in NUREG-0133 along with Regulatory Guide 1.109 Revision 1. The following sections provide the specific methodology which was utilized in calculating the  $P_i$  and  $R_i$  values for the various exposure pathways.

### 2.5.1 Calculation of $P_i$

The parameter,  $P_i$ , contained in the radioiodine and particulates portion of Section 2.2, includes pathway transport parameters of the  $i$ th radionuclide, the receptor's usage of the pathway media and the dosimetry of the exposure. Pathway usage rates and the internal dosimetry are functions of the receptor's age; however, the child age group will always receive the maximum dose under the exposure conditions assumed.

#### A. Inhalation Pathway

$$P_{iI} = K' (BR) DFA_i \quad 2.5-1$$

where

$P_{iI}$  = dose parameter for radionuclide  $i$  for the inhalation pathway, mrem/yr per  $\mu\text{Ci}/\text{m}^3$ ;

$K'$  = a constant of unit conversion,

=  $10^6 \text{ pCi}/\mu\text{Ci}$ ;

BR = the breathing rate of the child age group,  $\text{m}^3/\text{yr}$

$DFA_i$  = the maximum organ inhalation dose factor for the child age group for radionuclide  $i$ , mrem/pCi.

The age group considered is the child group. The child's breathing rate is taken as  $3700 \text{ m}^3/\text{yr}$  from Table E-5 of Regulatory Guide 1.109 Revision 1. The inhalation dose factors for the child,  $DFA_i$ , are presented in Table E-9 of Regulatory Guide 1.109 in units of mrem/pCi. The total body is considered as an organ in the selection of  $DFA_i$ .

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The incorporation of breathing rate of the child and the unit conversion factor results in the following:

$$P_{i1} = 3.7E9 \times DFA_i \quad 2.5-2$$

### 2.5.2 Calculation of R<sub>i</sub>

The radioiodine and particulate Control 2.3.1.A. is applicable to the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposure occurs. The inhalation and ground plane exposure pathways **SHALL** be considered to exist at all locations. The grass-goat-milk, the grass-cow-milk, grass-cow-meat, and vegetation pathways are considered based on their existence at the various locations. R<sub>i</sub> values have been calculated for the adult, teen, child, and infant age groups for the ground plane, cow milk, goat milk, vegetable and beef ingestion pathways. The methodology which was utilized to calculate these values is presented below.

#### A. Inhalation Pathway

$$R_{i1} = K'(BR)_a (DFA_i)_a \quad 2.5-3$$

where

R<sub>i1</sub> = dose factor for each identified radionuclide i of the organ of interest, mrem/yr per μCi/m<sup>3</sup>;

K' = a constant of unit conversion,  
= 10<sup>6</sup> pCi/μCi;

(BR)<sub>a</sub> = breathing rate of the receptor of age group a, m<sup>3</sup>/yr;

(DFA<sub>i</sub>)<sub>a</sub> = organ inhalation dose factor for radionuclide i for the receptor of age group a, mrem/pCi.



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The breathing rates (BR)<sub>a</sub> for the various age groups are tabulated below, as given in Table E-5 of the Regulatory Guide 1.109 Revision 1.

| <u>Age Group (a)</u> | <u>Breathing Rate (m<sup>3</sup>/yr)</u> |
|----------------------|--|
| Infant               | 1400                                     |
| Child                | 3700                                     |
| Teen                 | 8000                                     |
| Adult                | 8000                                     |

Inhalation dose factors (DFA<sub>i</sub>)<sub>a</sub> for the various age groups are given in Tables E-7 through E-10 of Regulatory Guide 1.109 Revision 1.

B. Ground Plane Pathway

$$R_{iG} = \frac{I_i K' K'' (SF) DFG_i (1 - e^{-\lambda_i t})}{\lambda_i} \quad 2.5-4$$

where

$R_{iG}$  = dose factor for the ground plane pathway for each identified radionuclide *i* for the organ of interest; mrem/yr per  $\mu\text{Ci}/\text{sec}$  per  $\text{m}^2$ ;

$K'$  = a constant of unit conversion,  
=  $10^6$  pCi/ $\mu\text{Ci}$ ;

$K''$  = a constant of unit conversion,  
= 8760 hr/yr;

$\lambda_i$  = the radiological decay constant for radionuclide *i*,  $\text{sec}^{-1}$ ;

$t$  = the exposure time, sec,  
=  $4.73 \times 10^8$  sec (15 years);

$DFG_i$  = the ground plane dose conversion factor for radionuclide *i*,  
mrem/hr per pCi/ $\text{m}^2$

SF = the shielding factor (dimensionless);

$I_i$  = factor to account for fractional deposition of radionuclide  $i$ .

For radionuclides other than iodine, the factor  $I_i$  is equal to one. For radioiodines, the value of  $I_i$  may vary. However, a value of 1.0 was used in calculating the R values in Table 7.

A shielding factor of 0.7 is suggested in Table E-15 of Regulatory Guide 1.109 Revision 1. A tabulation of DFG<sub>i</sub> values is presented in Table E-6 of Regulatory Guide 1.109 Revision 1.

C. Grass-Cow or Goat-Milk Pathway

$$R_{iM} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f} \left[ f_p f_s \left( \frac{r(1-e^{-\lambda_i t_{ep}})}{Y_p \lambda E_i} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right) + (1-f_p f_s) \left( \frac{r(1-e^{-\lambda_i t_{es}})}{Y_s \lambda E_i} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right) e^{-\lambda_i t_h} \right] \quad 2.5-5$$

where

- $R_{iM}$  = dose factor for the cow milk or goat milk pathway, for each identified radionuclide  $i$  for the organ of interest, mrem/yr per  $\mu\text{Ci}/\text{sec}$  per  $\text{m}^2$ ;
- $K'$  = a constant of unit conversion,  
=  $10^6 \text{ pCi}/\mu\text{Ci}$ ;
- $Q_F$  = the cow or goat feed consumption rate, kg/day (wet weight);
- $U_{ap}$  = the receptor's milk consumption rate for age group  $a$ , liters/yr;
- $Y_p$  = the agricultural productivity by unit area of pasture feed grass,  $\text{kg}/\text{m}^2$
- $Y_s$  = the agricultural productivity by unit area of stored feed,  $\text{kg}/\text{m}^2$

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- $F_m$  = the stable element transfer coefficients, pCi/liter per pCi/day;
- $r$  = fraction of deposited activity retained on cow feed grass;
- $(DFL_i)_a$  = the organ ingestion dose factor for radionuclide  $i$  for the receptor in age group  $a$ , mrem/pCi;
- $\lambda_{E_i}$  =  $\lambda_i + \lambda_w$
- $\lambda_i$  = the radiological decay constant for radionuclide  $i$ ,  $\text{sec}^{-1}$
- $\lambda_w$  = the decay constant for removal of activity on leaf and plant surfaces by weathering,  $\text{sec}^{-1}$ ,  
 =  $5.73 \times 10^{-7} \text{ sec}^{-1}$  (corresponding to a 14 day half-life);
- $t_f$  = the transport time from feed to cow or goat, to milk, to receptor, sec;
- $t_h$  = the transport time from harvest, to cow or goat, to consumption, sec;
- $t_b$  = period of time that activity builds up in soil, sec;
- $B_{iv}$  = concentration factor for uptake of radionuclide  $i$  from the soil by the edible parts of crops, pCi/kg (wet weight) per pCi/kg (dry soil);
- $P$  = effective surface density for soil, kg (dry soil)/ $\text{m}^2$ ;
- $f_p$  = fraction of the year that the cow or goat is on pasture;
- $f_s$  = fraction of the cow feed that is pasture grass while the cow is on pasture;
- $t_{ep}$  = period of pasture grass and crop exposure during the growing season, sec;
- $t_{es}$  = period of crop exposure during the growing season (stored feed); sec;
- $l_i$  = factor to account for fractional deposition of radionuclide  $i$ .

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For radionuclides other than iodine, the factor  $I_i$  is equal to one. For radioiodines, the value of  $I_i$  may vary. However, a value of 1.0 was used in calculating the R values Tables 14 through 21.

Milk cattle and goats are considered to be fed from two potential sources, pasture grass and stored feeds. Following the development in Regulatory Guide 1.109 Revision 1, the value of  $f_s$  is considered unity in lieu of site-specific information. The value of  $f_p$  is 0.500 based upon an 6 month grazing period.

Appendix C, Table 1 contains the appropriate parameter values and their source in Regulatory Guide 1.109 Revision 1.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the  $R_i$  is based on  $\chi/Q$ :

$$R_{T_M} = K'K''F_m Q_F U_{ap}(DFL)_a 0.75(0.5/H) \quad 2.5-6$$

where

$R_{T_M}$  = dose factor for the cow or goat milk pathway for tritium for the organ of interest, mrem/yr per mCi/m<sup>3</sup>;

$K''$  = a constant of conversion,

= 10<sup>3</sup> gm/kg;

H = absolute humidity of the atmosphere, gm/m<sup>3</sup>;

0.75 = the fraction of total feed that is water;

0.5 = the ratio of the specific activity of the feed grass water to the atmospheric water;

and the other parameters and values are as given above. A value for H of 8 grams/m<sup>3</sup>, was used in lieu of site-specific information.

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D. Grass-Cow-Meat Pathway

The integrated concentration in meat follows in a similar manner to the development for the milk pathway, therefore:

$$R_{iB} = I_i K' Q_F U_{ap} F_m (DFL_i)_a e^{-\lambda_i t_f} \left[ f_{pfs} \left[ \frac{r(1-e^{-\lambda_i t_{ep}})}{Y_p \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right] + (1-f_{pfs}) \left[ \frac{r(1-e^{-\lambda_i t_{es}})}{Y_s \lambda_{E_i}} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right] e^{-\lambda_i t_h} \right] \quad 2.5-7$$

where

- $R_{iB}$  = dose factor for the meat ingestion pathway for radionuclide  $i$  for any organ of interest, mRem/yr per  $\mu$ Ci/sec per  $m^{-2}$ ;
- $F_f$  = the stable element transfer coefficient, pCi/kg per pCi/day;
- $U_{ap}$  = the receptor's milk consumption rate for age group  $a$ , liters/yr;
- $t_s$  = the transport time from slaughter to meat consumption, sec;
- $t_h$  = the transport time from harvest, to animal consumption, sec;
- $t_{ep}$  = period of pasture grass exposure during the growing season, sec;
- $t_{es}$  = period of crop exposure during the growing season (stored feed); sec;
- $I_i$  = factor to account for fractional deposition of radionuclide  $i$ .

For radionuclides other than iodine, the factor  $I_i$  is equal to one. For radioiodines, the value of  $I_i$  may vary. However, a value of 1.0 was used in calculating  $R$  values in Tables 11 through 13.

All other terms remain the same as defined in Equation 2.5-5. Appendix C, Table 2 contains the values which were used in calculating  $R_i$  for the meat pathway.

|  |                                      |               |
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The concentration of tritium in meat is based on its airborne concentration rather than the deposition. Therefore, the  $R_i$  is based on  $\chi/Q$ .

$$R_{T_B} = K'K''F_fQ_FU_{ap}(DFL_i)_a \cdot 0.75(0.5/H) \quad 2.5-8$$

where

$$R_{T_B} = \text{dose factor for the meat ingestion pathway for tritium for any organ of interest, mrem/yr per mCi/m}^3,$$

All other terms are defined in Equation 2.5-6 and 2.5-7, above.

### E. Vegetation Pathway

The integrated concentration in vegetation consumed by man follows the expression developed in the derivation of the milk factor. Man is considered to consume two types of vegetation (fresh and stored) that differ only in the time period between harvest and consumption, therefore:

$$R_{i_v} = I_i K' (DFL_i)_a \left[ U_a^L e^{-\lambda_i t_L} \left[ \frac{r(1-e^{-\lambda_i t_e})}{Y_V \lambda_i E_i} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right] + U_a^S e^{-\lambda_i t_h} \right] \left[ \frac{r(1-e^{-\lambda_i t_e})}{Y_V \lambda_i E_i} + \frac{B_{iv}(1-e^{-\lambda_i t_b})}{\rho \lambda_i} \right] \quad 2.5-9$$

where

$$R_{i_v} = \text{dose factor for vegetable pathway for radionuclide } i \text{ for the organ of interest, mrem/yr per } \mu\text{Ci/sec per m}^{-2};$$

$$K' = \text{a constant of unit conversion,} \\ = 10^6 \text{ pCi}/\mu\text{Ci};$$

$$U_a^L = \text{the consumption rate of fresh leafy vegetation by the receptor in age group } a, \text{ kg/yr};$$

$$U_a^S = \text{the consumption rate of stored vegetation by the receptor in age group } a, \text{ kg/yr};$$

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- $f_L$  = the fraction of the annual intake of fresh leafy vegetation grown locally;
- $f_g$  = the traction of the annual intake of stored vegetation grown locally;
- $t_L$  = the average time between harvest of leafy vegetation and its consumption, sec;
- $t_h$  = the average time between harvest of stored vegetation and its consumption, sec;
- $Y_v$  = the vegetation areal density, kg/m<sup>2</sup>;
- $t_e$  = period of leafy vegetable exposure during growing season, sec;
- $I_i$  = factor to account for fractional deposition of radionuclide i.

For radionuclides other than iodine, the factor  $I_i$  is equal to one. For radioiodines, the value of  $I_i$  may vary. However, a value of 1.0 was used in calculating the R values in Tables 8 through 10. All other factors were defined above.

Appendix C, Table 3 presents the appropriate parameter values and their source in Regulatory Guide 1.109 Revision 1.

In lieu of site-specific data, default values for  $f_L$  and  $f_g$ , 1.0 and 0.76, respectively, were used in the calculation of  $R_i$ . These values were obtained from Table E-15 of Regulatory Guide 1.109 Revision 1.

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the  $R_i$  is based on  $\chi/Q$ :

$$R_{T_v} = K'K'' \left[ U_a^L f_L + U_a^S f_g \right] (DFI)_a \cdot 0.75(0.5/H) \quad 2.5-10$$

where

$$R_{T_v} = \text{dose factor for the vegetable pathway for tritium for any organ of interest, mrem/yr per mCi/m}^3,$$

All other terms remain the same as those in Equations 2.5-6 and 2.5-9.

|  |                                      |               |
|--|--------------------------------------|---------------|
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## 2.6 References

3. Monticello Nuclear Generating Plant Technical Specifications, TS-B.2.4-Radioactive Effluents, Specification 2.4.3F Rev. 25.
4. 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".
5. NSP - Monticello Nuclear Generating Plant, Appendix I Analysis - Supplement No. 1 - Docket No. 50-263, Table 2.1-3.
6. Boegli, J.S., et. al. Eds, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, NUREG-0133, 1978, NTIS, Springfield Va.
7. Sangendorf, J.F. and J. T. Goll, "XOQDOQ - Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations", NUREG-0324, 1977, USNRC, Washington, D.C.
8. USNRC, Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I", Rev. 1, Oct. 1977, USNRC, Washington.
9. USNRC, Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", July 1977. USNRC, Washington, D.C.
10. EPA, Title 40, Code of Federal Regulations, Part 190 "Environmental Radiation Protection Standards for Nuclear Power Operations".



Figure 1 Gaseous Radwaste

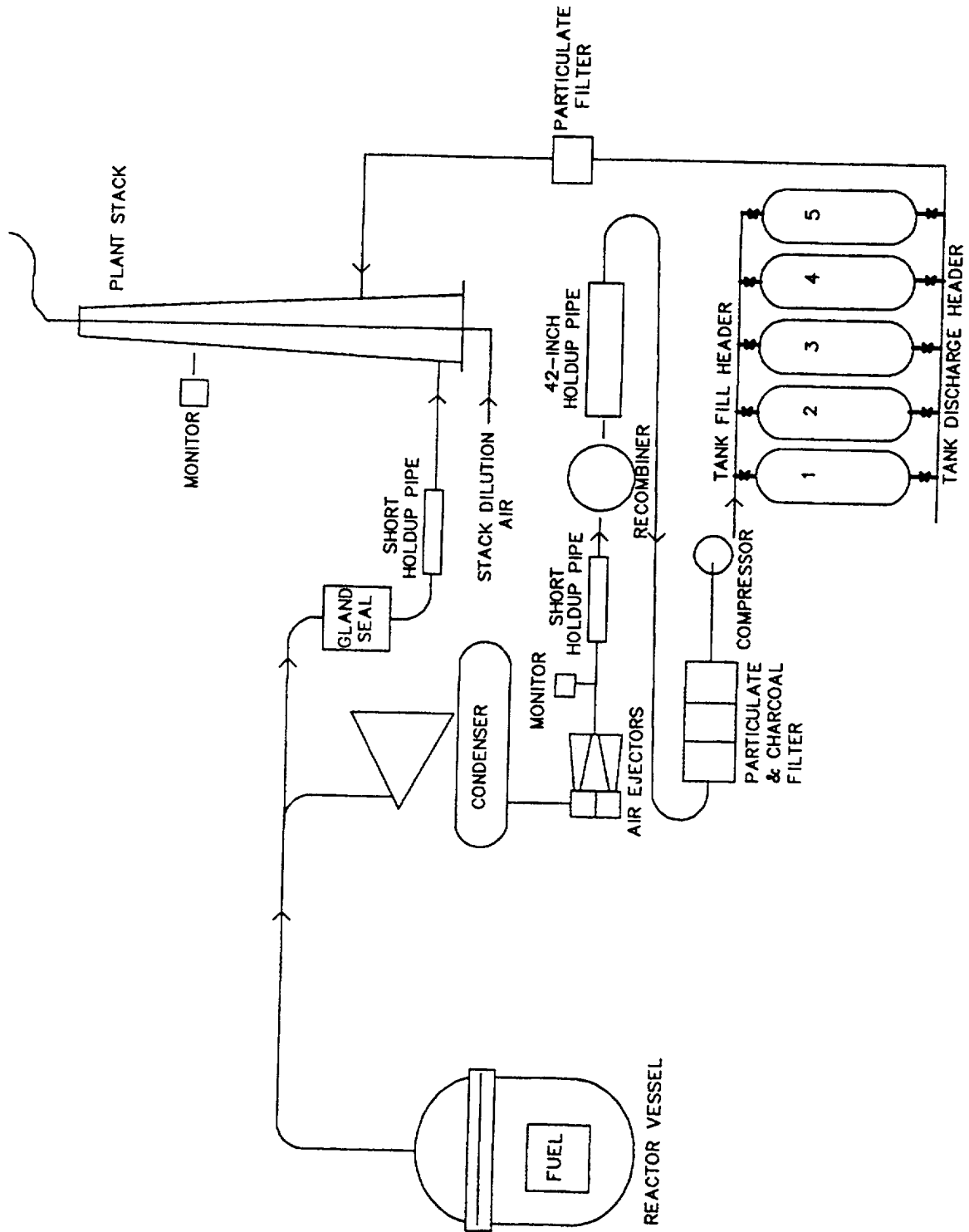
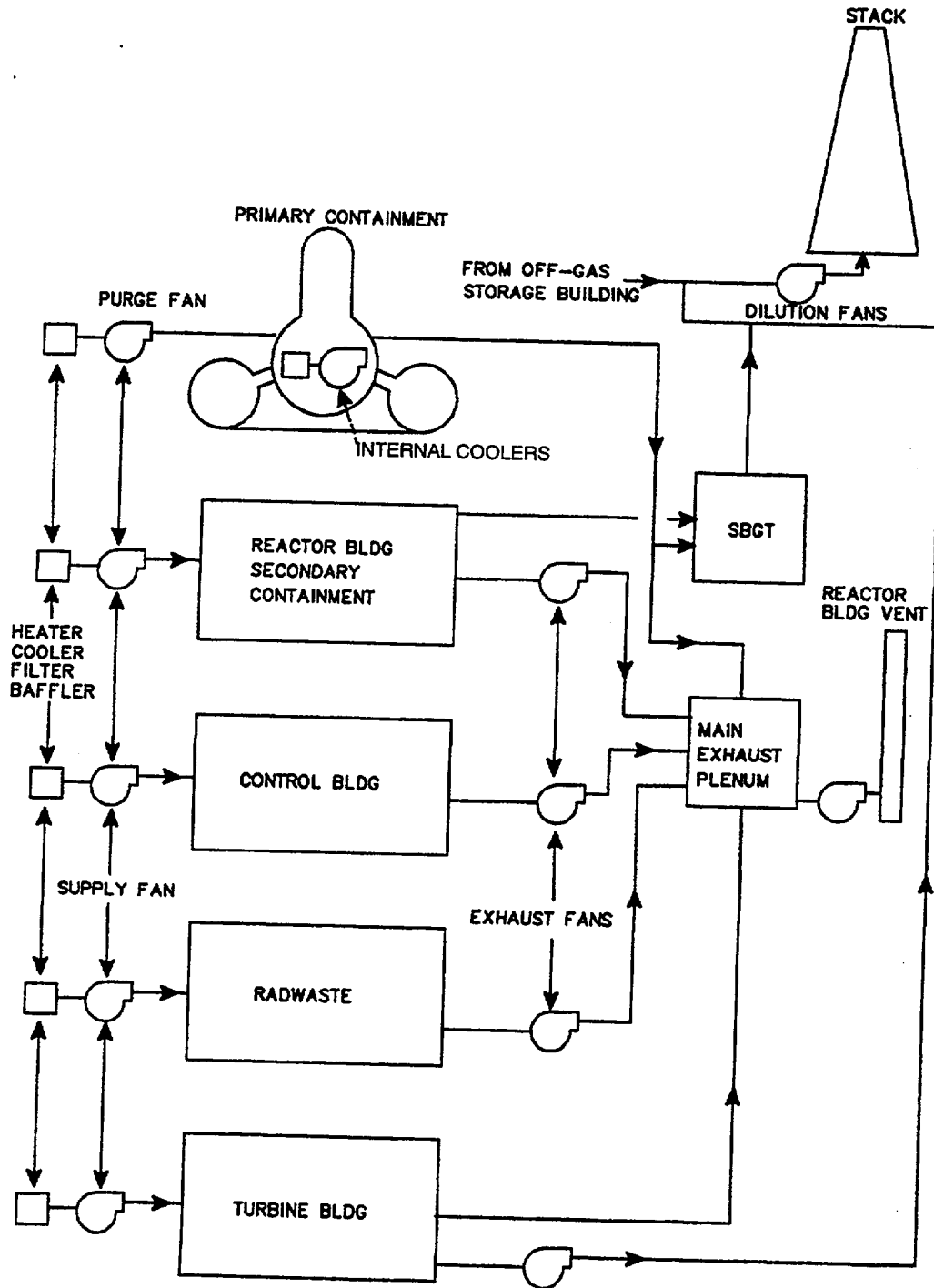


Figure 2 Ventilation System



|  |                                      |               |
|--|--------------------------------------|---------------|
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Table 1 Gaseous Source Terms<sup>(3)</sup> A<sub>i</sub>, Ci/yr

| Radionuclide | Reactor Building Vent | Gland Seal | Mechanical Vacuum Pump | Gaseous Radwaste | Drywell Purging |
|--------------|-----------------------|------------|------------------------|------------------|-----------------|
| Kr-83m       | --                    | 2.3E 01    | --                     | --               | --              |
| Kr-85m       | 7.1E 01               | 4.1E 01    | --                     | --               | 3.0E 00         |
| Kr-85        | --                    | --         | --                     | 1.3E 02          | --              |
| Kr-87        | 1.33E 02              | 1.4E 02    | --                     | --               | 3.0E 00         |
| Kr-88        | 2.33E 02              | 1.4E 02    | --                     | --               | 3.0E 00         |
| Kr-89        | --                    | 6.0E 02    | --                     | --               | --              |
| Kr-90        | --                    | --         | --                     | --               | --              |
| Xe-131m      | --                    | --         | --                     | 4.5E 01          | --              |
| Xe-133m      | --                    | 2.0E 00    | --                     | 2.7E 01          | --              |
| Xe-133       | 3.26E 02              | 5.6E 01    | 2.3E 03                | 8.9E 03          | 6.6E 01         |
| Xe-135m      | 6.96E 02              | 1.7E 01    | --                     | --               | 4.6E 01         |
| Xe-135       | 7.09E 02              | 1.5E 02    | 3.5E 02                | --               | 3.4E 01         |
| Xe-137       | --                    | 7.3E 02    | --                     | --               | --              |
| Xe-138       | 1.41E 03              | 5.6E 02    | --                     | --               | 7.0E 00         |
| Xe-139       | --                    | --         | --                     | --               | --              |
| Ar-41        | --                    | --         | --                     | --               | --              |
| Total        | 3.58E 03              | 2.46E 03   | 2.65E 03               | 9.10E 03         | 1.62E 02        |

|  |                                      |               |
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Table 2 Dose Factors and Constants for the Total Body and Skin for Gaseous Radionuclides

| Radionuclide | Total Whole Body<br>Dose Factor $K_i$<br>(mrem/yr per $\mu\text{Ci}/\text{m}^3$ ) | Total Skin Dose Factor<br>$L + 1.1M_i$<br>(mrem/yr per $\mu\text{Ci}/\text{m}^3$ ) | Total Body Dose Constant<br>for Long Term Releases $V_i$<br>(mrem/yr per $\mu\text{Ci}/\text{sec}$ ) |
|--------------|---|--|--|
| Kr-83m       | 7.56E-02  | 2.12E 01   | 2.61E-09   |
| Kr-85m       | 1.17E 03  | 2.81E 03   | 1.39E-04   |
| Kr-85        | 1.61E 01  | 1.36E 03   | 2.10E-06   |
| Kr-87        | 5.92E 03  | 1.65E 04   | 6.33E-04   |
| Kr-88        | 1.47E 04  | 1.91E 04   | 1.66E-03   |
| Kr-89        | 1.66E 04  | 2.91E 04   | 1.12E-03   |
| Kr-90        | 1.56E 04  | 2.52E 04   | 1.61E-04   |
| Xe-131m      | 9.15E 01  | 6.48E 02   | 3.31E-05   |
| Xe-133m      | 2.51E 02  | 1.35E 03   | 2.51E-05   |
| Xe-133       | 2.94E 02  | 6.94E 02   | 2.61E-05   |
| Xe-135m      | 3.12E 03  | 4.41E 03   | 3.34E-04   |
| Xe-135       | 1.81E 03  | 3.97E 03   | 2.24E-04   |
| Xe-137       | 1.42E 03  | 1.39E 04   | 9.99E-05   |
| Xe-138       | 8.83E 03  | 1.43E 04   | 9.90E-04   |
| Xe-139       | 5.02E 03  | 7.10E 04   | 5.79E-05   |
| Ar-41        | 8.84E 03  | 1.29E 04   | 1.20E-03   |

|  |                                      |               |
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Table 2 Dose Factors and Constants for the Total Body and Skin for Gaseous Radionuclides (cont'd)

| Radionuclide | Total Body Dose Constant for Short Term Releases $v_i$ (mrem/yr per $\mu\text{Ci}/\text{sec}$ ) | Total Skin Dose Constant for Long Term Releases $L_i(\chi/Q)_s \cdot 1.1B_i^*$ (mrem)/yr per $\mu\text{Ci}/\text{sec}$ ) | Total Dose Constant for Short Term Releases $L_i(\chi/q)_s \cdot 1.1b_i^*$ (mrem)/yr per $\mu\text{Ci}/\text{sec}$ ) |
|--------------|---|--|--|
| Kr-83m       | 2.99E-09  | 4.15E-07   | 4.75E-07   |
| Kr-85m       | 1.59E-04  | 3.90E-04   | 7.07E-04   |
| Kr-85        | 2.40E-06  | 1.52E-04   | 4.14E-04   |
| Kr-87        | 7.25E-04  | 2.13E-03   | 4.18E-03   |
| Kr-88        | 1.90E-03  | 3.00E-03   | 4.86E-03   |
| Kr-89        | 1.28E-03  | 2.97E-03   | 5.20E-03   |
| Kr-90        | 1.85E-04  | 1.08E-03   | 2.54E-03   |
| Xe-131m      | 3.79E-05  | 1.10E-04   | 2.11E-04   |
| Xe-133m      | 2.87E-05  | 1.55E-04   | 3.56E-04   |
| Xe-133       | 2.99E-05  | 7.88E-05   | 1.45E-04   |
| Xe-135m      | 3.82E-04  | 6.36E-04   | 8.54E-04   |
| Xe-135       | 2.57E-04  | 5.77E-04   | 9.94E-04   |
| Xe-137       | 1.14E-04  | 1.52E-03   | 3.92E-03   |
| Xe-138       | 1.13E-03  | 2.10E-03   | 3.13E-03   |
| Xe-139       | 6.63E-05  | 7.33E-03   | 2.01E-02   |
| Ar-41        | 1.57E-03  | 2.28E-03   | 3.10E-03   |

\*  $(\chi/Q)_s$ ,  $(\chi/q)_s$ ,  $B_i$ , and  $b_i$  values obtained from other tables in the ODCM.

Table 3 Air Ejector Monitor Trip Setting and Storage Tank Contents Storage Tank Activity in Dose Equivalent Curies Xe-133 12 Hours After Completion of Tank Fill Release Rate Set to 1.00 of Maximum Trip Setting

| Recoil/Diff/Eq | Qtot(5 Min) | Qtot(30 Min) | Condenser Air Inleakage, CFM |           |        |       |       |       |       |       |       |       |       |       |
|----------------|-------------|--------------|------------------------------|-----------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                |             |              | 3                            | 6         | 9      | 12    | 15    | 18    | 21    | 24    | 27    | 30    |       |       |
| 1.0            | 0.0         | 0.0          | 2.149E 06                    | 2.600E 05 | 956.   | 1492. | 1806. | 1970  | 2045. | 2068. | 2062. | 2039. | 2005. | 1965. |
| 0.9            | 0.1         | 0.0          | 1.876E 06                    | 2.600E 05 | 2008.  | 2459. | 2743. | 2880. | 2923. | 2912. | 2872. | 2815. | 2750. | 2680. |
| 0.9            | 0.0         | 0.1          | 2.042E 06                    | 2.600E 05 | 2480.  | 2585. | 2702. | 2747. | 2738. | 2697. | 2639. | 2572. | 2502. | 2431. |
| 0.8            | 0.2         | 0.0          | 1.664E 06                    | 2.600E 05 | 2823.  | 3206. | 3469. | 3584. | 3602. | 3565. | 3499. | 3416. | 3326. | 3234. |
| 0.8            | 0.1         | 0.1          | 1.772E 06                    | 2.600E 05 | 3371.  | 3444. | 3556. | 3589. | 3558. | 3490. | 3403. | 3308. | 3209. | 3111. |
| 0.8            | 0.2         | 0.2          | 1.925E 06                    | 2.600E 05 | 4145.  | 3779. | 3680. | 3595. | 3495. | 3384. | 3269. | 3155. | 3045. | 2939. |
| 0.7            | 0.3         | 0.0          | 1.495E 06                    | 2.600E 05 | 3471.  | 3802. | 4046. | 4144. | 4143. | 4086. | 3998. | 3895. | 3785. | 3674. |
| 0.7            | 0.2         | 0.1          | 1.565E 06                    | 2.600E 05 | 4053.  | 4102. | 4211. | 4233. | 4186. | 4098. | 3989. | 3871. | 3751. | 3633. |
| 0.7            | 0.1         | 0.2          | 1.661E 06                    | 2.600E 05 | 4842.  | 4507. | 4434. | 4554. | 4243. | 4114. | 3977. | 3840. | 3705. | 3576. |
| 0.7            | 0.0         | 0.3          | 1.797E 06                    | 2.600E 05 | 5971.  | 5088. | 4752. | 4526. | 4325. | 4137. | 3960. | 3794. | 3640. | 3496. |
| 0.6            | 0.4         | 0.0          | 1.385E 06                    | 2.600E 05 | 4000.  | 4288. | 4517. | 4602. | 4585. | 4510. | 4405. | 4285. | 4160. | 4034. |
| 0.6            | 0.3         | 0.1          | 1.402E 06                    | 2.600E 05 | 4593.  | 4621. | 4728. | 4743. | 4682. | 4578. | 4452. | 4317. | 4180. | 4045. |
| 0.6            | 0.2         | 0.2          | 1.460E 06                    | 2.600E 05 | 5370.  | 5059. | 5005. | 4928. | 4810. | 4667. | 4514. | 4358. | 4206. | 4060. |
| 0.6            | 0.1         | 0.3          | 1.540E 06                    | 2.600E 05 | 6435.  | 5659. | 5383. | 5182. | 4985. | 4789. | 4598. | 4415. | 4242. | 4080. |
| 0.6            | 0.0         | 0.4          | 1.655E 06                    | 2.600E 05 | 7982.  | 6530. | 5934. | 5551. | 5240. | 4967. | 4721. | 4498. | 4295. | 4109. |
| 0.5            | 0.5         | 0.0          | 1.243E 06                    | 2.600E 05 | 4440.  | 4691. | 4909. | 4982. | 4951. | 4862. | 4743. | 4609. | 4471. | 4332. |
| 0.5            | 0.4         | 0.1          | 1.270E 06                    | 2.600E 05 | 5030.  | 5043. | 5148. | 5156. | 5084. | 4967. | 4827. | 4678. | 4527. | 4379. |
| 0.5            | 0.3         | 0.2          | 1.303E 06                    | 2.600E 05 | 5784.  | 5492. | 5453. | 5379. | 5254. | 5101. | 4934. | 4765. | 4599. | 4439. |
| 0.5            | 0.2         | 0.3          | 1.347E 06                    | 2.600E 05 | 6782.  | 6086. | 5856. | 5673. | 5479. | 5278. | 5076. | 4881. | 4694. | 4518. |
| 0.5            | 0.1         | 0.4          | 1.408E 06                    | 2.600E 05 | 8165.  | 6909. | 6415. | 6082. | 5791. | 5523. | 5273. | 5041. | 4826. | 4627. |
| 0.5            | 0.0         | 0.5          | 1.498E 06                    | 2.600E 05 | 10208. | 8126. | 7241. | 6685. | 6552. | 5885. | 5663. | 5277. | 5021. | 4788. |
| 0.4            | 0.6         | 0.0          | 1.147E 06                    | 2.600E 05 | 4811.  | 5032. | 5240. | 5302. | 5261. | 5160. | 5028. | 4883. | 4733. | 4584. |
| 0.4            | 0.5         | 0.1          | 1.160E 06                    | 2.600E 05 | 5391.  | 5391. | 5494. | 5497. | 5417. | 5289. | 5137. | 4976. | 4814. | 4655. |
| 0.4            | 0.4         | 0.2          | 1.176E 06                    | 2.600E 05 | 6118.  | 5840. | 5813. | 5741. | 5612. | 5450. | 5273. | 5092. | 4915. | 4744. |
| 0.4            | 0.3         | 0.3          | 1.197E 06                    | 2.600E 05 | 7052.  | 6418. | 6223. | 6055. | 5864. | 5657. | 5448. | 5242. | 5045. | 4858. |
| 0.4            | 0.2         | 0.4          | 1.225E 06                    | 2.600E 05 | 8300.  | 7190. | 6771. | 6475. | 6199. | 5934. | 5681. | 5442. | 5218. | 5010. |
| 0.4            | 0.1         | 0.5          | 1.265E 06                    | 2.600E 05 | 10051. | 8273. | 7540. | 7063. | 6670. | 6322. | 6008. | 5723. | 5462. | 5223. |
| 0.4            | 0.0         | 0.6          | 1.324E 06                    | 2.600E 05 | 12686. | 9902. | 8697. | 7948. | 7378. | 6907. | 6501. | 6145. | 5828. | 5544. |

Table 3 Air Ejector Monitor Trip Setting and Storage Tank Contents Storage Tank Activity in Dose Equivalent Curies Xe-133 12 Hours After Completion of Tank Fill Release Rate Set to 1.00 of Maximum Trip Setting (cont'd)

|                | Condenser Air Inleakage, CFM |     |     |           |           |        |        |        |        |        |        |        |       |       |       |
|----------------|------------------------------|-----|-----|-----------|-----------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
|                | 3                            | 6   | 9   | 12        | 15        | 18     | 21     | 24     | 27     | 30     |        |        |       |       |       |
| Recoil/Diff/Eq | 0.3                          | 0.7 | 0.0 | 1.064E 06 | 2.600E 05 | 5148.  | 5324.  | 5522.  | 5577.  | 5526.  | 5415.  | 5273.  | 5117. | 4948. | 4800. |
| Qtot(5 Min)    | 0.3                          | 0.6 | 0.1 | 1.068E 06 | 2.600E 05 | 5695.  | 5684.  | 5786.  | 5784.  | 5697.  | 5559.  | 5398.  | 5227. | 5055. | 4887. |
| Qtot(30 Min)   | 0.3                          | 0.5 | 0.2 | 1.072E 06 | 2.600E 05 | 6392.  | 6127.  | 6110.  | 6040.  | 5907.  | 5737.  | 5551.  | 5362. | 5175. | 4995. |
|                | 0.3                          | 0.4 | 0.3 | 1.078E 06 | 2.600E 05 | 7268.  | 6684.  | 6517.  | 6361.  | 6171.  | 5961.  | 5744.  | 5531. | 5325. | 5129. |
|                | 0.3                          | 0.3 | 0.4 | 1.085E 06 | 2.600E 05 | 8404.  | 7406.  | 7046.  | 6777.  | 6513.  | 6251.  | 5995.  | 5751. | 5521. | 5304. |
|                | 0.3                          | 0.2 | 0.5 | 1.092E 06 | 2.600E 05 | 9937.  | 8380.  | 7758.  | 7338.  | 6975.  | 6642.  | 6333.  | 6047. | 5784. | 5540. |
|                | 0.3                          | 0.1 | 0.6 | 1.108E 06 | 2.600E 05 | 12115. | 9765.  | 8771.  | 8136.  | 7632.  | 7197.  | 6813.  | 6469. | 6158. | 5876. |
|                | 0.3                          | 0.0 | 0.7 | 1.129E 06 | 2.600E 05 | 15459. | 11891. | 10326. | 9361.  | 8639.  | 8051.  | 7550.  | 7115. | 6732. | 6391. |
|                | 0.2                          | 0.8 | 0.0 | 9.929E 05 | 2.600E 05 | 5403.  | 5576.  | 5767.  | 5814.  | 5755.  | 5635.  | 5484.  | 5320. | 5153. | 4987. |
|                | 0.2                          | 0.7 | 0.1 | 9.894E 05 | 2.600E 05 | 5954.  | 5934.  | 6034.  | 6029.  | 5935.  | 5790.  | 5620.  | 5441. | 5261. | 5085. |
|                | 0.2                          | 0.6 | 0.2 | 9.052E 05 | 2.600E 05 | 6621.  | 6366.  | 6358.  | 6289.  | 6153.  | 5977.  | 5784.  | 5587. | 5393. | 5204. |
|                | 0.2                          | 0.5 | 0.3 | 9.799E 05 | 2.600E 05 | 7444.  | 6901.  | 6757.  | 6610.  | 6422.  | 6209.  | 5987.  | 5768. | 5555. | 5352. |
|                | 0.2                          | 0.4 | 0.4 | 9.733E 05 | 2.600E 05 | 8487.  | 7577.  | 7263.  | 7017.  | 6762.  | 6502.  | 6244.  | 5996. | 5760. | 5538. |
|                | 0.2                          | 0.3 | 0.5 | 9.646E 05 | 2.600E 05 | 9849.  | 8462.  | 7924.  | 7548.  | 7207.  | 6885.  | 6508.  | 6295. | 6029. | 5782. |
|                | 0.2                          | 0.2 | 0.6 | 9.528E 05 | 2.600E 05 | 11706. | 9667.  | 8825.  | 8272.  | 7814.  | 7406.  | 7038.  | 6702. | 6395. | 6114. |
|                | 0.2                          | 0.1 | 0.7 | 9.357E 05 | 2.600E 05 | 14384. | 11405. | 10124. | 9316.  | 8689.  | 8159.  | 7698.  | 7289. | 6923. | 6593. |
|                | 0.2                          | 0.0 | 0.8 | 9.090E 05 | 2.600E 05 | 18586. | 14132. | 12163. | 10954. | 10061. | 9340.  | 8734.  | 8210. | 7751. | 7345. |
|                | 0.1                          | 0.9 | 0.0 | 9.305E 05 | 2.600E 05 | 5643.  | 5796.  | 5981.  | 6022.  | 5955.  | 5827.  | 5669.  | 5497. | 5322. | 5150. |
|                | 0.1                          | 0.8 | 0.1 | 9.217E 05 | 2.600E 05 | 6178.  | 6149.  | 6249.  | 6240.  | 6141.  | 5989.  | 5812.  | 5625. | 5439. | 5256. |
|                | 0.1                          | 0.7 | 0.2 | 9.112E 05 | 2.600E 05 | 6816.  | 6570.  | 6568.  | 6501.  | 6362.  | 6181.  | 5982.  | 5778. | 5577. | 5383. |
|                | 0.1                          | 0.6 | 0.3 | 8.985E 05 | 2.600E 05 | 7591.  | 7082.  | 6957.  | 6818.  | 6631.  | 6415.  | 6190.  | 5964. | 5764. | 5537. |
|                | 0.1                          | 0.5 | 0.4 | 8.826E 05 | 2.600E 05 | 8554.  | 7717.  | 7440.  | 7212.  | 6995.  | 6706.  | 6447.  | 6195. | 5955. | 5728. |
|                | 0.1                          | 0.4 | 0.5 | 8.624E 05 | 2.600E 05 | 9781.  | 8526.  | 8055.  | 7713.  | 7309.  | 7076.  | 6775.  | 6490. | 6222. | 5972. |
|                | 0.1                          | 0.3 | 0.6 | 8.358E 05 | 2.600E 05 | 11397. | 9593.  | 8865.  | 8374.  | 7951.  | 7564.  | 7207.  | 6877. | 6573. | 6293. |
|                | 0.1                          | 0.2 | 0.7 | 7.992E 05 | 2.600E 05 | 13625. | 11062. | 9982.  | 9284.  | 8723.  | 8236.  | 7802.  | 7411. | 7058. | 6736. |
|                | 0.1                          | 0.1 | 0.8 | 7.454E 05 | 2.600E 05 | 16890. | 13216. | 11619. | 10619. | 9856.  | 9222.  | 8675.  | 8194. | 7768. | 7385. |
|                | 0.1                          | 0.0 | 0.9 | 6.591E 05 | 2.600E 05 | 22138. | 16679. | 14250. | 12764. | 11676. | 10805. | 10077. | 9453. | 8909. | 8428. |
|                | 0.0                          | 1.0 | 0.0 | 8.755E 05 | 2.600E 05 | 5855.  | 5990.  | 6169.  | 6205.  | 6132.  | 5997.  | 5832.  | 5653. | 5472. | 5293. |
|                | 0.0                          | 0.9 | 0.1 | 8.628E 05 | 2.600E 05 | 6372.  | 6336.  | 6435.  | 6424.  | 6320.  | 6162.  | 5979.  | 5786. | 5593. | 5405. |
|                | 0.0                          | 0.8 | 0.2 | 8.477E 05 | 2.600E 05 | 6983.  | 6745.  | 6750.  | 6683.  | 6542.  | 6357.  | 6152.  | 5943. | 5732. | 5536. |
|                | 0.0                          | 0.7 | 0.3 | 8.296E 05 | 2.600E 05 | 7716.  | 7235.  | 7126.  | 6994.  | 6808.  | 6590.  | 6361.  | 6131. | 5908. | 5694. |
|                | 0.0                          | 0.6 | 0.4 | 8.075E 05 | 2.600E 05 | 8610.  | 7832.  | 7586.  | 7373.  | 7133.  | 6875.  | 6615.  | 6360. | 6117. | 5886. |

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Table 3 Air Ejector Monitor Trip Setting and Storage Tank Contents Storage Tank Activity in Dose Equivalent Curies Xe-133 12 Hours After Completion of Tank Fill Release Rate Set to 1.00 of Maximum Trip Setting (cont'd)

| Recoil/Diff/Eq | Qtot(5 Min) | Qtot(30 Min) | Condenser Air Inleakage, CFM |        |        |        |        |        |        |        |        |        |       |
|----------------|-------------|--------------|------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
|                |             |              | 3                            | 6      | 9      | 12     | 15     | 18     | 21     | 24     | 27     | 30     |       |
| 0.0            | 0.5         | 7.799E 05    | 2.600E 05                    | 9725   | 8578.  | 8160.  | 7846.  | 7538.  | 7231.  | 6932.  | 6647.  | 6378.  | 6126. |
| 0.0            | 0.4         | 7.446E 05    | 2.600E 05                    | 11156. | 9533.  | 8897.  | 8454.  | 8058.  | 7687.  | 7339.  | 7014.  | 6713.  | 6433. |
| 0.0            | 0.3         | 6.976E 05    | 2.600E 05                    | 13059. | 10807. | 9876.  | 9261.  | 8749.  | 8293.  | 7880.  | 7508.  | 7158.  | 6843. |
| 0.0            | 0.2         | 6.320E 05    | 2.600E 05                    | 15713. | 12581. | 11241. | 10386. | 9713.  | 9139.  | 8634.  | 8184.  | 7779.  | 7413. |
| 0.0            | 0.1         | 5.342E 05    | 2.600E 05                    | 19670. | 15227. | 13277. | 12065. | 11151. | 10401. | 9759.  | 9200.  | 8705.  | 8264. |
| 0.0            | 0.0         | 3.727E 05    | 2.600E 05                    | 26207. | 19597. | 16640. | 14838. | 13527. | 12484. | 11617. | 10878. | 10235. | 9670. |



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Table 4 Child Critical Organ Dose Parameters for Radionuclide i for the Inhalation Pathway

| Nuclide | $P_i$<br>mrem/yr $\mu\text{Ci}/\text{m}^3$ |
|---------|--|
| H-3     | 1.12E 03                                   |
| Cr-51   | 1.70E 04                                   |
| Mn-54   | 1.58E 06                                   |
| Fe-59   | 1.27E 06                                   |
| Co-58   | 1.11E 06                                   |
| Co-60   | 7.07E 06                                   |
| Zn-65   | 9.95E 05                                   |
| Rb-86   | 1.98E 05                                   |
| Sr-89   | 2.16E 06                                   |
| Sr-90   | 1.01E 08                                   |
| Y-91    | 2.63E 06                                   |
| Zr-95   | 2.23E 06                                   |
| Nb-95   | 6.14E 05                                   |
| Ru-103  | 6.62E 05                                   |
| Ru-106  | 1.43E 07                                   |
| Ag-110m | 5.48E 06                                   |
| Te-127m | 1.48E 06                                   |
| Te-129m | 1.76E 06                                   |
| Cs-134  | 1.01E 06                                   |
| Cs-136  | 1.71E 05                                   |
| Cs-137  | 9.07E 05                                   |
| Ba-140  | 1.74E 06                                   |
| Ce-141  | 5.44E 05                                   |
| Ce-144  | 1.20E 07                                   |
| I-131   | 1.62E 07                                   |
| I-133   | 3.85E 06                                   |
| I-135   | 7.92E 05                                   |

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Table 5 Dose Factors for Noble Gases and Daughters That May Be Detected in Gaseous Effluents

| Radionuclide | Total Body Dose Factor $K_i$<br>mrem/yr $\mu\text{Ci}/\text{m}^3$ | Skin Dose Factor $L_i$<br>mrem/yr $\mu\text{Ci}/\text{m}^3$ | Gamma Air Dose Factor $M_i$<br>mrad/yr $\mu\text{Ci}/\text{m}^3$ | Beta Air Dose Factor $N_i$<br>mrad/yr $\mu\text{Ci}/\text{m}^3$ |
|--------------|---|---|--|---|
| Kr-83m       | 7.56E-02  | --  | 1.93E+01   | 2.88E+02  |
| 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  |
| Xe-139       | 5.02E+03  | 6.52E+04  | 5.28E+03   | 6.52E+04  |
| Ar-41        | 8.84E+03  | 2.69E+03  | 9.30E+03   | 3.28E+03  |

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Table 6 Dose Parameters for Finite Evaluated Plumes for the Critical Boundary Location 0.51 mi from the Stack in the SSE Sector

|                        | Long Term Release*                              |  | Short Term Release**                            |  |
|------------------------|---|--|---|--|
|                        | Total Body<br>$V_i$<br><u>mrem/yr</u><br>Ci/sec | Gamma Air<br>$B_i$<br><u>mrad/yr</u><br>Ci/sec | Total Body<br>$v_i$<br><u>mrem/yr</u><br>Ci/sec | Gamma Air<br>$b_i$<br><u>mrad/yr</u><br>Ci/sec |
| Noble Gas Radionuclide |   |  |   |  |
| Kr-83m                 | 2.61E-09  | 3.77E-07                                       | 2.99E-09  | 4.32E-07                                       |
| Kr-85m                 | 1.39E-04  | 2.07E-04                                       | 1.59E-04  | 2.37E-04                                       |
| Kr-85                  | 2.10E-06  | 3.18E-06                                       | 2.40E-06  | 3.64E-06                                       |
| Kr-87                  | 6.33E-04  | 9.52E-04                                       | 7.25E-02  | 1.09E-03                                       |
| Kr-88                  | 1.66E-03  | 2.49E-03                                       | 1.90E-03  | 2.85E-03                                       |
| Kr-89                  | 1.12E-03  | 1.68E-03                                       | 1.28E-03  | 1.92E-03                                       |
| Kr-90                  | 1.61E-04  | 2.42E-04                                       | 1.85E-04  | 2.78E-04                                       |
| Xe-131m                | 3.31E-05  | 5.21E-05                                       | 3.79E-05  | 5.97E-05                                       |
| Xe-133m                | 2.51E-05  | 4.09E-05                                       | 2.87E-05  | 4.68E-05                                       |
| Xe-133                 | 2.61E-05  | 4.08E-05                                       | 2.99E-05  | 4.67E-05                                       |
| Xe-135m                | 3.34E-04  | 5.06E-04                                       | 3.82E-04  | 5.79E-04                                       |
| Xe-135                 | 2.24E-04  | 3.37E-04                                       | 2.57E-04  | 3.89E-04                                       |
| Xe-137                 | 9.99E-05  | 1.51E-04                                       | 1.14E-04  | 1.73E-04                                       |
| Xe-138                 | 9.90E-04  | 1.49E-03                                       | 1.13E-03  | 1.70E-03                                       |
| Xe-139                 | 5.79E-05  | 8.69E-05                                       | 6.63E-05  | 9.95E-05                                       |
| Ar-41                  | 1.20E-03  | 1.80E-03                                       | 1.38E-03  | 2.07E-03                                       |

\* Values are annual average

\*\* Values are for 144 hours per year purge.

Table 7 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Ground Pathway

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| Cr-51   | 4.66E 06 | 4.66E 06 | 4.66E 06 | 4.66E 06 | 4.66E 06 | 4.66E 06 | 4.66E 06 | 5.51E 06 |
| Mn-54   | 1.34E 09 | 1.34E 09 | 1.34E 09 | 1.34E 09 | 1.34E 09 | 1.34E 09 | 1.34E 09 | 1.57E 09 |
| Fe-59   | 2.75E 08 | 2.75E 08 | 2.75E 08 | 2.75E 08 | 2.75E 08 | 2.75E 08 | 2.75E 08 | 3.23E 08 |
| Co-58   | 3.79E 08 | 3.79E 08 | 3.79E 08 | 3.79E 08 | 3.79E 08 | 3.79E 08 | 3.79E 08 | 4.44E 08 |
| Co-60   | 2.15E 10 | 2.15E 10 | 2.15E 10 | 2.15E 10 | 2.15E 10 | 2.15E 10 | 2.15E 10 | 2.52E 10 |
| Zn-65   | 7.49E 08 | 7.49E 08 | 7.49E 08 | 7.49E 08 | 7.49E 08 | 7.49E 08 | 7.49E 08 | 8.69E 10 |
| Sr-89   | 2.23E 04 | 2.23E 04 | 2.23E 04 | 2.23E 04 | 2.23E 04 | 2.23E 04 | 2.23E 04 | 2.58E 04 |
| Zr-95   | 2.49E 08 | 2.49E 08 | 2.49E 08 | 2.49E 08 | 2.49E 08 | 2.49E 08 | 2.49E 08 | 2.89E 08 |
| I-131   | 1.72E 07 | 1.72E 07 | 1.72E 07 | 1.72E 07 | 1.72E 07 | 1.72E 07 | 1.72E 07 | 2.09E 07 |
| I-133   | 2.47E 06 | 2.47E 06 | 2.47E 06 | 2.47E 06 | 2.47E 06 | 2.47E 06 | 2.47E 06 | 3.00E 06 |
| I-135   | 2.52E 06 | 2.52E 06 | 2.52E 06 | 2.52E 06 | 2.52E 06 | 2.52E 06 | 2.52E 06 | 2.94E 06 |
| Cs-134  | 6.82E 09 | 6.82E 09 | 6.82E 09 | 6.82E 09 | 6.82E 09 | 6.82E 09 | 6.82E 09 | 7.96E 09 |
| Cs-136  | 1.49E 08 | 1.49E 08 | 1.49E 08 | 1.49E 08 | 1.49E 08 | 1.49E 08 | 1.49E 08 | 1.69E 08 |
| Cs-137  | 1.03E 10 | 1.03E 10 | 1.03E 10 | 1.03E 10 | 1.03E 10 | 1.03E 10 | 1.03E 10 | 1.20E 10 |
| Ba-140  | 2.05E 07 | 2.05E 07 | 2.05E 07 | 2.05E 07 | 2.05E 07 | 2.05E 07 | 2.05E 07 | 2.34E 07 |
| Ce-141  | 1.36E 07 | 1.36E 07 | 1.36E 07 | 1.36E 07 | 1.36E 07 | 1.36E 07 | 1.36E 07 | 1.53E 07 |
| Ce-144  | 6.96E 07 | 6.96E 07 | 6.96E 07 | 6.96E 07 | 6.96E 07 | 6.96E 07 | 6.96E 07 | 8.04E 07 |
| Nb-95   | 1.36E 08 | 1.36E 08 | 1.36E 08 | 1.36E 08 | 1.36E 08 | 1.36E 08 | 1.36E 08 | 1.60E 08 |
| Ru-103  | 1.08E 08 | 1.08E 08 | 1.08E 08 | 1.08E 08 | 1.08E 08 | 1.08E 08 | 1.08E 08 | 1.26E 08 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

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Table 8 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Vegetable Pathway Adult Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 2.28E 03 | 2.28E 03 | 0.00E 00 | 2.28E 03 | 2.28E 03 | 2.28E 03 | 2.28E 03 | 2.28E 03 |
| Cr-51   | 4.60E 04 | 1.16E 07 | 0.00E 00 | 0.00E 00 | 1.01E 04 | 2.75E 04 | 6.10E 04 | 0.00E 00 |
| Mn-54   | 5.83E 07 | 9.36E 08 | 0.00E 00 | 3.05E 08 | 9.09E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.12E 08 | 9.75E 08 | 1.24E 08 | 2.93E 08 | 0.00E 00 | 0.00E 00 | 8.17E 07 | 0.00E 00 |
| Co-58   | 6.71E 07 | 6.07E 08 | 0.00E 00 | 2.99E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 3.67E 08 | 3.12E 09 | 0.00E 00 | 1.66E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 5.77E 08 | 8.04E 08 | 4.01E 08 | 1.28E 09 | 8.54E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 2.87E 08 | 1.60E 09 | 1.00E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.64E 11 | 1.93E 10 | 6.70E 11 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 2.51E 05 | 1.17E 09 | 1.16E 06 | 3.71E 05 | 5.82E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 6.61E 07 | 3.04E 07 | 8.07E 07 | 1.15E 08 | 1.98E 08 | 3.78E 10 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.12E 06 | 3.30E 06 | 2.11E 06 | 3.67E 06 | 6.40E 06 | 5.39E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 3.73E 04 | 1.14E 05 | 3.86E 04 | 1.01E 05 | 1.62E 05 | 6.67E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 8.83E 09 | 1.89E 08 | 4.54E 09 | 1.08E 10 | 3.49E 09 | 0.00E 00 | 1.16E 09 | 0.00E 00 |
| Cs-136  | 1.19E 08 | 1.88E 07 | 4.19E 07 | 1.66E 08 | 9.21E 07 | 0.00E 00 | 1.26E 07 | 0.00E 00 |
| Cs-137  | 5.94E 08 | 1.76E 08 | 6.63E 09 | 9.07E 09 | 3.08E 09 | 0.00E 00 | 1.02E 09 | 0.00E 00 |
| Ba-140  | 8.40E 06 | 2.64E 08 | 1.28E 08 | 1.61E 05 | 5.47E 04 | 0.00E 00 | 9.22E 04 | 0.00E 00 |
| Ce-141  | 1.48E 04 | 4.99E 08 | 1.93E 05 | 1.31E 05 | 6.07E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 1.69E 06 | 1.07E 10 | 3.15E 07 | 1.32E 07 | 7.82E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 4.19E 04 | 4.73E 08 | 1.40E 05 | 7.80E 04 | 7.71E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 2.03E 06 | 5.51E 08 | 4.72E 06 | 0.00E 00 | 1.80E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

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Table 9 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Vegetable Pathway Teen Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 2.61E 03 | 2.61E 03 | 0.00E 00 | 2.61E 03 | 2.61E 03 | 2.61E 03 | 2.61E 03 | 2.61E 03 |
| Cr-51   | 6.11E 04 | 1.03E 07 | 0.00E 00 | 0.00E 00 | 1.34E 04 | 3.39E 04 | 8.72E 04 | 0.00E 00 |
| Mn-54   | 8.79E 07 | 9.09E 08 | 0.00E 00 | 4.43E 08 | 1.32E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.60E 08 | 9.78E 08 | 1.77E 08 | 4.14E 08 | 0.00E 00 | 0.00E 00 | 1.30E 08 | 0.00E 00 |
| Co-58   | 9.79E 07 | 5.85E 08 | 0.00E 00 | 4.25E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 5.57E 08 | 3.22E 09 | 0.00E 00 | 2.47E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 8.68E 08 | 7.88E 08 | 5.36E 08 | 1.86E 09 | 1.19E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 4.36E 08 | 1.81E 09 | 1.52E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 2.05E 11 | 2.33E 10 | 8.32E 11 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 3.68E 05 | 1.23E 09 | 1.69E 06 | 5.35E 05 | 7.86E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 5.77E 07 | 2.13E 07 | 7.68E 07 | 1.07E 08 | 1.85E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.01E 06 | 2.51E 06 | 1.96E 06 | 3.32E 06 | 5.83E 06 | 3.14E 10 | 0.00E 00 | 0.00E 00 |
| I-135   | 3.33E 04 | 9.96E 04 | 3.49E 04 | 8.98E 04 | 1.42E 05 | 4.64E 08 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 7.54E 09 | 2.02E 08 | 6.90E 09 | 1.62E 10 | 5.16E 10 | 5.78E 06 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 1.13E 08 | 1.35E 07 | 4.28E 07 | 1.68E 08 | 9.16E 07 | 0.00E 00 | 1.97E 09 | 0.00E 00 |
| Cs-137  | 4.90E 09 | 2.00E 08 | 1.06E 10 | 1.41E 10 | 4.78E 09 | 0.00E 00 | 1.44E 07 | 0.00E 00 |
| Ba-140  | 8.88E 06 | 2.12E 08 | 1.38E 08 | 1.69E 05 | 5.72E 04 | 0.00E 00 | 1.86E 09 | 0.00E 00 |
| Ce-141  | 2.12E 04 | 5.29E 08 | 2.77E 05 | 1.85E 05 | 8.70E 04 | 0.00E 00 | 1.14E 05 | 0.00E 00 |
| Ce-144  | 2.72E 06 | 1.27E 10 | 5.05E 07 | 2.09E 07 | 1.25E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 5.78E 04 | 4.49E 08 | 1.89E 05 | 1.05E 05 | 1.02E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 2.88E 06 | 5.64E 08 | 6.75E 06 | 0.00E 00 | 2.38E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 10 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Vegetable Pathway Child Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 4.04E 03 | 4.04E 03 | 0.00E 00 | 4.04E 03 | 4.04E 03 | 4.04E 03 | 4.04E 03 | 4.04E 03 |
| Cr-51   | 1.16E 05 | 6.15E 06 | 0.00E 00 | 0.00E 00 | 1.76E 04 | 6.44E 04 | 1.18E 05 | 0.00E 00 |
| Mn-54   | 1.73E 08 | 5.44E 08 | 0.00E 00 | 6.49E 08 | 1.82E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 3.17E 08 | 6.62E 08 | 3.93E 08 | 6.36E 08 | 0.00E 00 | 0.00E 00 | 1.84E 08 | 0.00E 00 |
| Co-58   | 1.92E 08 | 3.66E 08 | 0.00E 00 | 6.27E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 1.11E 09 | 2.08E 09 | 0.00E 00 | 3.76E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 1.70E 09 | 4.81E 08 | 1.03E 09 | 2.74E 09 | 1.73E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 1.03E 09 | 1.40E 09 | 3.62E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 3.49E 11 | 1.86E 10 | 1.38E 12 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 7.44E 05 | 8.71E 08 | 3.80E 06 | 8.35E 05 | 1.20E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 8.16E 07 | 1.28E 07 | 1.43E 08 | 1.44E 08 | 2.36E 08 | 4.75E 10 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.67E 06 | 1.78E 06 | 3.57E 06 | 4.42E 06 | 7.36E 06 | 8.21E 08 | 0.00E 00 | 0.00E 00 |
| I-135   | 5.28E 04 | 8.50E 04 | 6.20E 04 | 1.12E 05 | 1.71E 05 | 9.88E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 5.40E 09 | 1.38E 08 | 1.56E 10 | 2.56E 10 | 7.93E 09 | 0.00E 00 | 2.84E 09 | 0.00E 00 |
| Cs-136  | 1.43E 08 | 7.77E 06 | 8.04E 07 | 2.21E 08 | 1.18E 08 | 0.00E 00 | 1.76E 07 | 0.00E 00 |
| Cs-137  | 3.52E 09 | 1.50E 08 | 2.40E 10 | 2.39E 10 | 7.78E 09 | 0.00E 00 | 2.80E 09 | 0.00E 00 |
| Ba-140  | 1.61E 07 | 1.40E 08 | 2.76E 08 | 2.42E 05 | 7.87E 04 | 0.00E 00 | 1.44E 05 | 0.00E 00 |
| Ce-141  | 4.75E 04 | 3.39E 08 | 6.42E 05 | 3.20E 05 | 1.40E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 6.50E 06 | 9.95E 09 | 1.22E 08 | 3.82E 07 | 2.11E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 1.12E 05 | 2.91E 08 | 4.04E 05 | 1.57E 05 | 1.48E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 5.83E 06 | 3.82E 08 | 1.52E 07 | 0.00E 00 | 3.82E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 11 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Meat Pathway Adult Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 3.27E 02 | 3.27E 02 | 0.00E 00 | 3.27E 02 | 3.27E 02 | 3.27E 02 | 3.27E 02 | 3.27E 02 |
| Cr-51   | 3.26E 03 | 8.21E 05 | 0.00E 00 | 0.00E 00 | 7.19E 02 | 1.95E 03 | 4.33E 03 | 0.00E 00 |
| Mn-54   | 8.98E 05 | 1.44E 07 | 0.00E 00 | 4.71E 06 | 1.40E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.12E 08 | 9.73E 08 | 1.24E 08 | 2.92E 08 | 0.00E 00 | 0.00E 00 | 8.16E 07 | 0.00E 00 |
| Co-58   | 1.95E 07 | 1.76E 08 | 0.00E 00 | 8.68E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 8.87E 07 | 7.55E 08 | 0.00E 00 | 4.02E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 3.06E 08 | 4.27E 08 | 2.13E 08 | 6.78E 08 | 4.53E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 4.12E 06 | 2.30E 07 | 1.43E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.76E 09 | 2.07E 08 | 7.17E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 1.94E 05 | 9.07E 08 | 8.92E 05 | 2.86E 05 | 4.49E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 4.33E 06 | 1.99E 06 | 5.28E 06 | 7.55E 06 | 1.29E 07 | 2.48E 09 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.13E-01 | 3.34E-01 | 2.14E-01 | 3.72E-01 | 6.49E-01 | 5.46E 01 | 0.00E 00 | 0.00E 00 |
| I-135   | 1.78E-17 | 5.38E-17 | 1.82E-17 | 4.77E-17 | 7.64E-17 | 3.14E-15 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 6.68E 08 | 1.43E 07 | 3.43E 08 | 8.17E 08 | 2.64E 08 | 0.00E 00 | 8.78E 07 | 0.00E 00 |
| Cs-136  | 1.61E 07 | 2.53E 06 | 5.65E 06 | 2.23E 07 | 1.24E 07 | 0.00E 00 | 1.70E 06 | 0.00E 00 |
| Cs-137  | 4.33E 08 | 1.28E 07 | 4.83E 08 | 6.61E 08 | 2.24E 08 | 0.00E 00 | 7.46E 07 | 0.00E 00 |
| Ba-140  | 9.01E 05 | 2.83E 07 | 1.38E 07 | 1.73E 04 | 5.87E 03 | 0.00E 00 | 9.89E 03 | 0.00E 00 |
| Ce-141  | 4.96E 02 | 1.67E 07 | 6.47E 03 | 4.38E 03 | 2.03E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 3.94E 04 | 2.48E 08 | 7.34E 05 | 3.07E 05 | 1.82E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 3.00E 05 | 3.39E 09 | 1.01E 06 | 5.59E 05 | 5.52E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 2.00E 07 | 5.42E 09 | 4.64E 07 | 0.00E 00 | 1.77E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.



Table 12 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Meat Pathway Teen Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.95E 02 | 1.95E 02 | 0.00E 00 | 1.95E 02 | 1.95E 02 | 1.95E 02 | 1.95E 02 | 1.95E 02 |
| Cr-51   | 2.61E 03 | 4.39E 05 | 0.00E 00 | 0.00E 00 | 5.72E 02 | 1.45E 03 | 3.75E 03 | 0.00E 00 |
| Mn-54   | 7.12E 05 | 7.37E 06 | 0.00E 00 | 3.59E 06 | 1.07E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 8.95E 07 | 5.48E 08 | 9.93E 07 | 2.32E 08 | 0.00E 00 | 0.00E 00 | 7.31E 07 | 0.00E 00 |
| Co-58   | 1.54E 07 | 9.22E 07 | 0.00E 00 | 6.69E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 7.03E 07 | 4.06E 08 | 0.00E 00 | 3.12E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 2.43E 08 | 2.20E 08 | 1.50E 08 | 5.20E 08 | 3.33E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 3.47E 06 | 1.44E 07 | 1.21E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.15E 09 | 1.30E 08 | 4.64E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 1.55E 05 | 5.02E 08 | 7.15E 05 | 2.25E 05 | 3.31E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 3.30E 06 | 1.22E 06 | 4.39E 06 | 6.14E 06 | 1.06E 07 | 1.79E 09 | 0.00E 00 | 0.00E 00 |
| I-133   | 9.25E-02 | 2.30E-01 | 1.79E-01 | 3.03E-01 | 5.32E-01 | 4.23E 01 | 0.00E 00 | 0.00E 00 |
| I-135   | 1.41E-17 | 4.22E-17 | 1.48E-17 | 3.81E-17 | 6.02E-17 | 2.45E-17 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 2.98E 08 | 7.99E 06 | 2.73E 08 | 6.42E 08 | 2.04E 08 | 0.00E 00 | 7.79E 07 | 0.00E 00 |
| Cs-136  | 1.16E 07 | 1.40E 06 | 4.41E 06 | 1.73E 07 | 9.44E 06 | 0.00E 00 | 1.49E 06 | 0.00E 00 |
| Cs-137  | 1.86E 08 | 7.59E 06 | 4.01E 08 | 5.34E 08 | 1.82E 08 | 0.00E 00 | 7.06E 07 | 0.00E 00 |
| Ba-140  | 7.33E 05 | 1.75E 07 | 1.14E 07 | 1.39E 04 | 4.72E 03 | 0.00E 00 | 9.37E 03 | 0.00E 00 |
| Ce-141  | 4.17E 02 | 1.04E 07 | 5.43E 03 | 3.63E 03 | 1.71E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 3.32E 04 | 1.56E 08 | 6.18E 05 | 2.56E 05 | 1.53E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 2.39E 05 | 1.86E 09 | 7.84E 05 | 4.35E 05 | 4.22E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 1.62E 07 | 3.16E 09 | 3.79E 07 | 0.00E 00 | 1.33E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 13 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Meat Pathway Child Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 2.36E 02 | 2.36E 02 | 0.00E 00 | 2.36E 02 | 2.36E 02 | 2.36E 02 | 2.36E 02 | 2.36E 02 |
| Cr-51   | 4.07E 03 | 2.16E 05 | 0.00E 00 | 0.00E 00 | 6.17E 02 | 2.26E 03 | 4.12E 03 | 0.00E 00 |
| Mn-54   | 1.09E 05 | 3.45E 06 | 0.00E 00 | 4.11E 06 | 1.15E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.42E 08 | 2.79E 08 | 1.76E 08 | 2.85E 08 | 0.00E 00 | 0.00E 00 | 8.26E 07 | 0.00E 00 |
| Co-58   | 2.39E 07 | 4.56E 07 | 0.00E 00 | 7.82E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 1.09E 08 | 2.05E 08 | 0.00E 00 | 3.70E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 3.72E 08 | 1.05E 08 | 2.25E 08 | 5.99E 08 | 3.77E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 6.55E 06 | 8.87E 06 | 2.29E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.52E 09 | 8.08E 07 | 6.00E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 2.48E 05 | 2.91E 08 | 1.27E 06 | 2.79E 05 | 3.99E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 4.65E 06 | 7.29E 05 | 8.14E 06 | 8.19E 06 | 1.34E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.55E 01 | 1.66E 01 | 3.32E 01 | 4.11E 01 | 6.85E 01 | 2.71E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 2.28E 17 | 3.67E 17 | 2.68E 17 | 4.82E 17 | 7.39E 17 | 7.63E 01 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 1.67E 08 | 4.26E 06 | 4.81E 08 | 7.90E 08 | 2.45E 08 | 4.27E 15 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 1.35E 07 | 7.34E 05 | 7.60E 06 | 2.09E 07 | 1.11E 07 | 0.00E 00 | 8.78E 07 | 0.00E 00 |
| Cs-137  | 1.04E 08 | 4.43E 06 | 7.39E 08 | 7.07E 08 | 2.30E 08 | 0.00E 00 | 1.66E 06 | 0.00E 00 |
| Ba-140  | 1.22E 06 | 1.06E 07 | 2.10E 07 | 1.84E 04 | 5.98E 03 | 0.00E 00 | 8.29E 07 | 0.00E 00 |
| Ce-141  | 7.57E 02 | 6.36E 06 | 1.02E 04 | 5.10E 03 | 2.24E 03 | 0.00E 00 | 1.10E 04 | 0.00E 00 |
| Ce-144  | 6.22E 04 | 9.53E 09 | 1.17E 06 | 3.66E 05 | 2.02E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 3.77E 05 | 9.74E 08 | 1.35E 06 | 5.27E 05 | 4.95E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 2.63E 07 | 1.77E 09 | 6.83E 07 | 0.00E 00 | 1.72E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 14 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Cow Milk Pathway Adult Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     |          |          |          |          |          |          |          |          |
| Cr-51   | 1.32E 04 | 3.32E 06 | 0.00E 00 | 0.00E 00 | 2.91E 03 | 7.90E 03 | 1.75E 04 | 0.00E 00 |
| Mn-54   | 8.25E 05 | 1.32E 07 | 0.00E 00 | 4.32E 06 | 1.29E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.25E 07 | 1.09E 08 | 1.39E 07 | 3.26E 07 | 0.00E 00 | 0.00E 00 | 9.10E 06 | 0.00E 00 |
| Co-58   | 5.03E 06 | 4.55E 07 | 0.00E 00 | 2.24E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 1.93E 07 | 1.65E 08 | 0.00E 00 | 8.77E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 1.18E 09 | 1.65E 09 | 8.21E 08 | 2.61E 09 | 1.75E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 1.97E 07 | 1.10E 08 | 6.85E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 6.62E 09 | 7.80E 08 | 2.70E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 9.72E 01 | 4.55E 05 | 4.48E 02 | 1.44E 02 | 2.25E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 1.19E 08 | 5.49E 07 | 1.45E 08 | 2.08E 08 | 3.57E 08 | 6.82E 10 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.05E 06 | 3.09E 06 | 1.98E 06 | 3.44E 06 | 6.01E 06 | 5.06E 08 | 0.00E 00 | 0.00E 00 |
| I-135   | 5.70E 03 | 1.74E 04 | 5.90E 03 | 1.54E 04 | 2.48E 04 | 1.02E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 5.74E 09 | 1.23E 08 | 2.95E 09 | 7.02E 09 | 2.27E 09 | 0.00E 00 | 7.54E 08 | 0.00E 00 |
| Cs-136  | 3.35E 08 | 5.60E 07 | 1.25E 08 | 4.93E 08 | 2.74E 08 | 0.00E 00 | 3.76E 07 | 0.00E 00 |
| Cs-137  | 3.66E 09 | 1.08E 08 | 4.09E 09 | 5.59E 09 | 1.90E 09 | 0.00E 00 | 6.31E 08 | 0.00E 00 |
| Ba-140  | 8.43E 05 | 2.65E 07 | 1.29E 07 | 1.62E 04 | 5.49E 03 | 0.00E 00 | 9.25E 03 | 0.00E 00 |
| Ce-141  | 1.71E 02 | 5.78E 06 | 2.24E 03 | 1.51E 03 | 7.02E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 4.67E 03 | 6.09E 07 | 1.80E 05 | 7.53E 04 | 4.46E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 1.08E 04 | 1.22E 08 | 3.60E 04 | 2.01E 04 | 1.98E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 1.93E 02 | 5.24E 04 | 4.49E 02 | 0.00E 00 | 1.71E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

|  |                                      |               |
|--|--------------------------------------|---------------|
| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                                      | ODCM-05.01    |
| <b>TITLE:</b>                              | <b>GASEOUS EFFLUENT CALCULATIONS</b> | Revision 3    |
|  |                                      | Page 55 of 66 |

Table 15 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Cow Milk Pathway Teen Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.00E 03 | 1.00E 03 | 0.00E 00 | 1.00E 03 | 1.00E 03 | 1.00E 03 | 1.00E 03 | 1.00E 03 |
| Cr-51   | 2.31E 04 | 3.88E 06 | 0.00E 00 | 0.00E 00 | 5.06E 03 | 1.28E 04 | 3.30E 04 | 0.00E 00 |
| Mn-54   | 1.43E 06 | 1.48E 07 | 0.00E 00 | 7.20E 06 | 2.15E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 2.18E 07 | 1.34E 08 | 2.42E 07 | 5.65E 07 | 0.00E 00 | 0.00E 00 | 1.78E 07 | 0.00E 00 |
| Co-58   | 8.70E 06 | 5.12E 07 | 0.00E 00 | 3.78E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 3.35E 07 | 1.94E 08 | 0.00E 00 | 1.49E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 2.04E 09 | 1.85E 09 | 1.26E 09 | 4.38E 09 | 2.80E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 3.62E 07 | 1.50E 08 | 1.26E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 9.42E 09 | 1.07E 09 | 3.81E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 1.70E 02 | 5.70E 05 | 7.83E 02 | 2.47E 02 | 3.63E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 1.98E 08 | 7.31E 07 | 2.64E 08 | 3.69E 08 | 6.36E 08 | 1.08E 11 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.87E 06 | 4.64E 06 | 3.61E 06 | 6.13E 06 | 1.08E 07 | 8.56E 08 | 0.00E 00 | 0.00E 00 |
| I-135   | 9.99E 03 | 2.99E 04 | 1.05E 04 | 2.70E 04 | 4.26E 04 | 1.74E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 5.60E 09 | 1.50E 08 | 5.12E 09 | 1.21E 10 | 3.83E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 5.62E 08 | 6.73E 07 | 2.13E 08 | 8.37E 08 | 4.55E 08 | 0.00E 00 | 1.46E 09 | 0.00E 00 |
| Cs-137  | 3.44E 09 | 1.40E 08 | 7.42E 09 | 9.87E 09 | 3.36E 09 | 0.00E 00 | 7.18E 07 | 0.00E 00 |
| Ba-140  | 1.50E 06 | 3.58E 07 | 2.32E 07 | 2.84E 09 | 9.65E 03 | 0.00E 00 | 1.30E 09 | 0.00E 00 |
| Ce-141  | 3.14E 02 | 7.83E 06 | 4.10E 03 | 2.74E 03 | 1.29E 03 | 0.00E 00 | 1.91E 04 | 0.00E 00 |
| Ce-144  | 1.78E 04 | 8.33E 07 | 3.31E 05 | 1.37E 05 | 8.19E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 1.88E 04 | 1.46E 07 | 6.16E 04 | 3.42E 04 | 3.31E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 3.41E 02 | 6.67E 04 | 7.99E 02 | 0.00E 00 | 2.82E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

|  |                                      |               |
|--|--------------------------------------|---------------|
| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                                      | ODCM-05.01    |
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Table 16 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Cow Milk Pathway Child Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.58E 03 | 1.58E 03 | 0.00E 00 | 1.58E 03 | 1.58E 03 | 1.58E 03 | 1.58E 03 | 1.58E 03 |
| Cr-51   | 4.71E 04 | 2.50E 06 | 0.00E 00 | 0.00E 00 | 7.14E 03 | 2.61E 04 | 4.77E 04 | 0.00E 00 |
| Mn-54   | 2.87E 06 | 9.04E 06 | 0.00E 00 | 1.08E 07 | 3.02E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 4.52E 07 | 9.45E 07 | 5.61E 07 | 9.08E 07 | 0.00E 00 | 0.00E 00 | 2.63E 07 | 0.00E 00 |
| Co-58   | 1.77E 07 | 3.37E 07 | 0.00E 00 | 5.77E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 6.81E 07 | 1.28E 08 | 0.00E 00 | 2.31E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 4.10E 09 | 1.16E 09 | 2.47E 09 | 6.59E 09 | 4.15E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 8.93E 07 | 1.21E 08 | 3.13E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.63E 10 | 8.68E 08 | 6.44E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 3.56E 02 | 4.17E 05 | 1.82E 03 | 4.00E 02 | 5.72E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 3.66E 08 | 5.73E 07 | 6.40E 08 | 6.44E 08 | 1.06E 09 | 2.13E 11 | 0.00E 00 | 0.00E 00 |
| I-133   | 4.11E 06 | 4.38E 06 | 8.78E 06 | 1.09E 07 | 1.81E 07 | 2.02E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 2.11E 04 | 3.40E 04 | 2.48E 04 | 4.46E 04 | 6.85E 04 | 3.95E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 4.09E 09 | 1.05E 08 | 1.18E 10 | 1.94E 10 | 6.01E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 8.53E 08 | 4.63E 07 | 4.80E 08 | 1.32E 09 | 7.02E 08 | 0.00E 00 | 2.16E 09 | 0.00E 00 |
| Cs-137  | 2.52E 09 | 1.07E 08 | 1.79E 10 | 1.71E 10 | 5.57E 09 | 0.00E 00 | 1.05E 08 | 0.00E 00 |
| Ba-140  | 3.27E 06 | 2.84E 07 | 5.60E 07 | 4.91E 04 | 1.60E 04 | 0.00E 00 | 2.00E 09 | 0.00E 00 |
| Ce-141  | 7.47E 02 | 6.28E 06 | 1.01E 04 | 5.03E 03 | 2.21E 03 | 0.00E 00 | 2.93E 04 | 0.00E 00 |
| Ce-144  | 4.36E 04 | 6.68E 07 | 8.17E 05 | 2.56E 05 | 1.42E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 3.87E 04 | 1.00E 08 | 1.39E 05 | 5.41E 04 | 5.09E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 7.26E 02 | 4.88E 04 | 1.89E 03 | 0.00E 00 | 4.75E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

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ODCM-05.01

**TITLE:**

**GASEOUS EFFLUENT CALCULATIONS**

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Table 17 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Cow Milk Pathway Infant Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 2.40E 03 | 2.40E 03 | 0.00E 00 | 2.40E 03 | 2.40E 03 | 2.40E 03 | 2.40E 03 | 2.40E 03 |
| Cr-51   | 7.46E 04 | 2.17E 06 | 0.00E 00 | 0.00E 00 | 1.06E 04 | 4.87E 04 | 9.47E 04 | 0.00E 00 |
| Mn-54   | 4.54E 06 | 7.36E 06 | 0.00E 00 | 2.00E 07 | 4.44E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 7.21E 07 | 8.74E 07 | 1.05E 08 | 1.83E 08 | 0.00E 00 | 0.00E 00 | 5.41E 07 | 0.00E 00 |
| Co-58   | 2.88E 07 | 2.88E 07 | 0.00E 00 | 1.15E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 1.11E 08 | 1.12E 08 | 0.00E 00 | 4.71E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 5.26E 09 | 9.63E 09 | 3.32E 09 | 1.14E 10 | 5.53E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 1.70E 08 | 1.22E 08 | 5.94E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.79E 10 | 8.75E 08 | 7.01E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 5.58E 02 | 3.92E 05 | 3.23E 03 | 7.87E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 6.92E 08 | 5.62E 07 | 1.34E 09 | 1.57E 09 | 8.48E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-133   | 7.91E 06 | 4.57E 06 | 1.85E 07 | 2.70E 07 | 1.84E 09 | 5.17E 11 | 0.00E 00 | 0.00E 00 |
| I-135   | 3.74E 04 | 3.71E 04 | 5.16E 04 | 1.03E 05 | 3.17E 07 | 4.91E 09 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 3.59E 09 | 9.65E 07 | 1.90E 10 | 3.55E 10 | 1.14E 05 | 9.20E 06 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 1.03E 09 | 4.19E 07 | 9.37E 08 | 2.76E 09 | 9.14E 09 | 0.00E 00 | 3.75E 09 | 0.00E 00 |
| Cs-137  | 2.37E 09 | 1.04E 08 | 2.85E 10 | 3.34E 10 | 1.10E 09 | 0.00E 00 | 2.25E 08 | 0.00E 00 |
| Ba-140  | 5.94E 06 | 2.83E 07 | 1.15E 08 | 1.15E 05 | 8.96E 09 | 0.00E 00 | 3.63E 09 | 0.00E 00 |
| Ce-141  | 1.44E 03 | 6.30E 06 | 2.00E 04 | 1.22E 04 | 2.74E 04 | 0.00E 00 | 7.08E 04 | 0.00E 00 |
| Ce-144  | 6.56E 04 | 6.72E 07 | 1.17E 06 | 4.79E 05 | 3.76E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 6.18E 09 | 9.02E 07 | 2.59E 05 | 1.07E 05 | 1.94E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 1.28E 03 | 4.65E 04 | 3.82E 03 | 0.00E 00 | 7.66E 04 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
|         |          |          |          |          | 7.96E 03 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 18 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Goat Milk Pathway Adult Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.57E 03 | 1.57E 03 | 0.00E 00 | 1.57E 03 | 1.57E 03 | 1.57E 03 | 1.57E 03 | 1.57E 03 |
| Cr-51   | 1.59E 03 | 3.99E 05 | 0.00E 00 | 0.00E 00 | 3.49E 02 | 9.48E 02 | 2.11E 03 | 0.00E 00 |
| Mn-54   | 9.89E 04 | 1.59E 06 | 0.00E 00 | 0.00E 00 | 1.59E 05 | 9.48E 02 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 1.62E 05 | 1.41E 06 | 1.80E 05 | 4.23E 05 | 0.00E 00 | 0.00E 00 | 1.18E 05 | 0.00E 00 |
| Co-58   | 6.03E 05 | 5.46E 06 | 0.00E 00 | 2.69E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 2.32E 06 | 1.98E 07 | 0.00E 00 | 1.05E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 1.42E 08 | 1.97E 08 | 9.85E 07 | 3.14E 08 | 2.10E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 4.13E 07 | 2.31E 08 | 1.44E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.39E 10 | 1.64E 09 | 5.67E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 1.17E 01 | 5.46E 04 | 5.37E 01 | 1.72E 01 | 2.70E 01 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 1.43E 08 | 6.59E 07 | 1.74E 08 | 2.50E 08 | 4.28E 08 | 8.18E 10 | 0.00E 00 | 0.00E 00 |
| I-133   | 1.26E 06 | 3.71E 06 | 2.37E 06 | 4.13E 06 | 7.21E 06 | 6.07E 08 | 0.00E 00 | 0.00E 00 |
| I-135   | 6.83E 03 | 2.09E 04 | 7.08E 03 | 1.85E 04 | 2.97E 04 | 1.22E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 1.72E 10 | 3.69E 08 | 8.85E 09 | 2.11E 10 | 6.82E 09 | 0.00E 00 | 2.26E 09 | 0.00E 00 |
| Cs-136  | 1.06E 09 | 1.68E 08 | 3.75E 08 | 1.48E 09 | 8.25E 08 | 0.00E 00 | 1.13E 08 | 0.00E 00 |
| Cs-137  | 1.10E 10 | 3.25E 08 | 1.23E 10 | 1.68E 10 | 5.70E 09 | 0.00E 00 | 1.89E 09 | 0.00E 00 |
| Ba-140  | 1.01E 05 | 3.18E 06 | 1.54E 06 | 1.94E 03 | 6.59E 02 | 0.00E 00 | 1.11E 03 | 0.00E 00 |
| Ce-141  | 2.06E 01 | 6.94E 05 | 2.68E 02 | 1.81E 02 | 8.43E 01 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

|  |                                      |               |
|--|--------------------------------------|---------------|
| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                                      | ODCM-05.01    |
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Table 19 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Goat Milk Pathway Teen Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 2.04E 03 | 2.04E 03 | 0.00E 00 | 2.04E 03 | 2.04E 03 | 2.04E 03 | 2.04E 03 | 2.04E 03 |
| Cr-51   | 2.77E 03 | 4.66E 05 | 0.00E 00 | 0.00E 00 | 6.07E 02 | 1.54E 02 | 3.95E 03 | 0.00E 00 |
| Mn-54   | 1.71E 05 | 1.77E 06 | 0.00E 00 | 8.64E 05 | 2.58E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 2.83E 05 | 1.74E 06 | 3.14E 05 | 7.34E 05 | 0.00E 00 | 0.00E 00 | 2.31E 05 | 0.00E 00 |
| Co-58   | 1.04E 06 | 6.25E 06 | 0.00E 00 | 4.53E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 4.02E 06 | 2.32E 07 | 0.00E 00 | 1.78E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 2.45E 08 | 2.22E 08 | 1.51E 08 | 5.25E 08 | 3.36E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 7.59E 07 | 3.16E 08 | 2.65E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 1.98E 10 | 2.25E 09 | 8.01E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 2.04E 01 | 6.84E 04 | 9.40E 01 | 2.97E 01 | 4.36E 01 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 2.38E 08 | 8.77E 07 | 3.17E 08 | 4.43E 08 | 7.63E 08 | 1.29E 11 | 0.00E 00 | 0.00E 00 |
| I-133   | 2.24E 06 | 5.57E 06 | 4.34E 06 | 7.36E 06 | 1.29E 07 | 1.03E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 1.20E 04 | 3.59E 04 | 1.26E 04 | 3.24E 04 | 5.11E 04 | 2.08E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 1.68E 10 | 4.50E 08 | 1.54E 10 | 3.62E 10 | 1.15E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 1.69E 09 | 2.02E 08 | 6.38E 08 | 2.51E 09 | 1.37E 09 | 0.00E 00 | 4.39E 09 | 0.00E 00 |
| Cs-137  | 1.03E 10 | 4.21E 08 | 2.22E 10 | 2.96E 10 | 1.01E 01 | 0.00E 00 | 2.15E 08 | 0.00E 00 |
| Ba-140  | 1.80E 05 | 4.30E 06 | 2.79E 06 | 3.41E 03 | 1.16E 03 | 0.00E 00 | 3.91E 09 | 0.00E 00 |
| Ce-141  | 3.77E 01 | 9.39E 05 | 4.92E 02 | 3.28E 02 | 1.55E 02 | 0.00E 00 | 2.30E 03 | 0.00E 00 |
| Ce-144  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.



|  |                                      |               |
|--|--------------------------------------|---------------|
| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                                      | ODCM-05.01    |
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Table 20 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Goat Milk Pathway Child Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 3.23E 03 | 3.23E 03 | 0.00E 00 | 3.23E 03 | 3.23E 03 | 3.23E 03 | 3.23E 03 | 3.23E 03 |
| Cr-51   | 5.65E 03 | 3.00E 05 | 0.00E 00 | 0.00E 00 | 8.57E 02 | 3.14E 03 | 5.73E 03 | 0.00E 00 |
| Mn-54   | 3.44E 05 | 1.08E 06 | 0.00E 00 | 1.29E 06 | 3.62E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 5.88E 05 | 1.23E 06 | 7.29E 05 | 1.18E 05 | 0.00E 00 | 0.00E 00 | 3.42E 05 | 0.00E 00 |
| Co-58   | 2.12E 06 | 4.04E 06 | 0.00E 00 | 6.92E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 8.17E 06 | 1.53E 07 | 0.00E 00 | 2.77E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 4.92E 08 | 1.39E 08 | 2.97E 08 | 7.19E 08 | 4.98E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 1.87E 08 | 2.54E 08 | 6.56E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 3.43E 10 | 1.82E 09 | 1.35E 11 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 4.27E 01 | 5.01E 04 | 2.18E 02 | 4.80E 01 | 6.87E 01 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 4.39E 08 | 6.88E 07 | 7.68E 08 | 7.72E 08 | 1.27E 09 | 2.55E 11 | 0.00E 00 | 0.00E 00 |
| I-133   | 4.93E 06 | 5.25E 06 | 1.05E 07 | 1.30E 07 | 2.17E 07 | 2.42E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 2.53E 04 | 4.08E 04 | 2.98E 04 | 5.36E 04 | 8.22E 04 | 4.74E 06 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 1.23E 10 | 3.14E 08 | 3.55E 10 | 5.82E 10 | 1.80E 10 | 0.00E 00 | 6.47E 09 | 0.00E 00 |
| Cs-136  | 2.56E 09 | 1.39E 08 | 1.44E 09 | 3.96E 09 | 2.11E 09 | 0.00E 00 | 3.14E 08 | 0.00E 00 |
| Cs-137  | 7.57E 09 | 3.21E 08 | 5.36E 10 | 5.13E 10 | 1.67E 10 | 0.00E 00 | 6.01E 09 | 0.00E 00 |
| Ba-140  | 3.92E 05 | 3.41E 06 | 6.72E 06 | 5.89E 03 | 1.92E 03 | 0.00E 00 | 3.51E 03 | 0.00E 00 |
| Ce-141  | 8.97E 01 | 7.45E 05 | 1.21E 03 | 6.04E 02 | 2.65E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ce-144  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 21 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Goat Milk Pathway Infant Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 4.90E 03 | 4.90E 03 | 0.00E 00 | 4.90E 03 | 4.90E 03 | 4.90E 03 | 4.90E 03 | 4.90E 03 |
| Cr-51   | 8.95E 03 | 2.61E 05 | 0.00E 00 | 0.00E 00 | 1.28E 03 | 5.84E 03 | 1.14E 04 | 0.00E 00 |
| Mn-54   | 5.45E 05 | 8.83E 06 | 0.00E 00 | 2.40E 06 | 5.33E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Fe-59   | 9.37E 05 | 1.14E 06 | 1.36E 06 | 2.38E 06 | 0.00E 00 | 0.00E 00 | 7.03E 05 | 0.00E 00 |
| Co-58   | 3.45E 06 | 3.45E 06 | 0.00E 00 | 1.38E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Co-60   | 1.34E 07 | 1.35E 07 | 0.00E 00 | 5.65E 06 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zn-65   | 6.31E 08 | 1.16E 09 | 3.99E 08 | 1.37E 09 | 6.63E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-89   | 3.58E 08 | 2.57E 08 | 1.25E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Sr-90   | 3.75E 10 | 1.84E 09 | 1.47E 11 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Zr-95   | 6.70E 01 | 4.70E 04 | 3.88E 02 | 9.45E 01 | 1.02E 02 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| I-131   | 8.31E 08 | 6.74E 07 | 1.60E 09 | 1.89E 09 | 2.21E 09 | 6.21E 11 | 0.00E 00 | 0.00E 00 |
| I-133   | 9.49E 06 | 5.48E 06 | 2.23E 07 | 3.24E 07 | 3.81E 07 | 5.89E 09 | 0.00E 00 | 0.00E 00 |
| I-135   | 4.49E 04 | 4.46E 04 | 6.19E 04 | 1.23E 05 | 1.37E 05 | 1.10E 07 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 1.08E 10 | 2.89E 08 | 5.71E 10 | 1.07E 11 | 2.74E 10 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Cs-136  | 3.09E 09 | 1.26E 08 | 2.81E 09 | 8.27E 09 | 3.30E 09 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Cs-137  | 7.10E 09 | 3.13E 08 | 8.55E 10 | 1.00E 11 | 2.69E 10 | 0.00E 00 | 6.74E 08 | 0.00E 00 |
| Ba-140  | 7.13E 05 | 3.40E 06 | 1.38E 04 | 1.38E 07 | 3.29E 03 | 0.00E 00 | 1.09E 10 | 0.00E 00 |
| Ce-141  | 1.72E 02 | 7.57E 05 | 2.40E 03 | 1.46E 03 | 4.52E 02 | 0.00E 00 | 8.50E 03 | 0.00E 00 |
| Ce-144  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Nb-95   | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |
| Ru-103  | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 22 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Inhalation Pathway Adult Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.26E 03 | 1.26E 03 | 0.00E 00 | 1.26E 03 | 1.26E 03 | 1.26E 03 | 1.26E 03 | 1.26E 03 |
| Cr-51   | 9.99E 01 | 3.32E 03 | 0.00E 00 | 0.00E 00 | 2.28E 01 | 5.94E 01 | 1.44E 04 | 0.00E 00 |
| Mn-54   | 6.29E 03 | 7.72E 04 | 0.00E 00 | 3.95E 04 | 9.83E 03 | 0.00E 00 | 4.10E 06 | 0.00E 00 |
| Fe-59   | 1.05E 04 | 1.88E 05 | 1.17E 04 | 2.77E 04 | 0.00E 00 | 0.00E 00 | 1.01E 06 | 0.00E 00 |
| Co-58   | 2.07E 03 | 1.06E 05 | 0.00E 00 | 1.58E 03 | 0.00E 00 | 0.00E 00 | 9.27E 05 | 0.00E 00 |
| Co-60   | 1.48E 04 | 2.84E 05 | 0.00E 00 | 1.15E 04 | 0.00E 00 | 0.00E 00 | 5.96E 06 | 0.00E 00 |
| Zn-65   | 4.65E 04 | 5.34E 04 | 3.24E 04 | 1.03E 05 | 6.89E 04 | 0.00E 00 | 8.63E 05 | 0.00E 00 |
| Sr-89   | 8.71E 03 | 3.49E 05 | 3.04E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 1.40E 06 | 0.00E 00 |
| Sr-90   | 6.09E 06 | 7.21E 05 | 9.91E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 9.59E 06 | 0.00E 00 |
| Zr-95   | 2.32E 04 | 1.50E 05 | 1.07E 05 | 3.44E 04 | 5.41E 04 | 0.00E 00 | 1.77E 06 | 0.00E 00 |
| I-131   | 2.05E 04 | 6.27E 03 | 2.52E 04 | 3.57E 04 | 6.12E 04 | 1.19E 07 | 0.00E 00 | 0.00E 00 |
| I-133   | 4.51E 03 | 8.87E 03 | 8.63E 03 | 1.48E 04 | 2.58E 04 | 2.15E 06 | 0.00E 00 | 0.00E 00 |
| I-135   | 2.57E 03 | 5.25E 03 | 2.68E 03 | 6.98E 03 | 1.11E 04 | 4.48E 05 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 7.27E 05 | 1.04E 04 | 3.72E 05 | 8.47E 05 | 2.87E 05 | 0.00E 00 | 9.75E 04 | 0.00E 00 |
| Cs-136  | 1.10E 05 | 1.17E 04 | 3.90E 04 | 1.46E 05 | 8.55E 04 | 0.00E 00 | 1.20E 04 | 0.00E 00 |
| Cs-137  | 4.27E 05 | 8.39E 03 | 4.78E 05 | 6.20E 05 | 2.22E 05 | 0.00E 00 | 7.51E 04 | 0.00E 00 |
| Ba-140  | 2.56E 03 | 2.18E 05 | 3.90E 04 | 4.90E 01 | 1.67E 01 | 0.00E 00 | 1.27E 06 | 0.00E 00 |
| Ce-141  | 1.53E 03 | 1.20E 05 | 1.99E 04 | 1.35E 04 | 6.25E 03 | 0.00E 00 | 3.61E 05 | 0.00E 00 |
| Ce-144  | 1.84E 05 | 8.16E 05 | 3.43E 06 | 1.43E 06 | 8.48E 05 | 0.00E 00 | 7.78E 06 | 0.00E 00 |
| Nb-95   | 4.21E 03 | 1.04E 05 | 1.41E 03 | 7.82E 03 | 7.72E 03 | 0.00E 00 | 5.05E 05 | 0.00E 00 |
| Ru-103  | 6.58E 02 | 1.10E 05 | 1.53E 03 | 0.00E 00 | 5.83E 03 | 0.00E 00 | 5.05E 05 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 23 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Inhalation Pathway Teen Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.27E 03 | 1.27E 03 | 0.00E 00 | 1.27E 03 | 1.27E 03 | 1.27E 03 | 1.27E 03 | 1.27E 03 |
| Cr-51   | 1.35E 02 | 3.00E 03 | 0.00E 00 | 0.00E 00 | 3.07E 01 | 7.49E 01 | 2.09E 04 | 0.00E 00 |
| Mn-54   | 8.39E 03 | 6.67E 04 | 0.00E 00 | 5.10E 04 | 1.27E 04 | 0.00E 00 | 1.98E 06 | 0.00E 00 |
| Fe-59   | 1.43E 04 | 1.78E 05 | 1.59E 04 | 3.69E 04 | 0.00E 00 | 0.00E 00 | 1.53E 06 | 0.00E 00 |
| Co-58   | 2.77E 03 | 9.51E 04 | 0.00E 00 | 2.07E 03 | 0.00E 00 | 0.00E 00 | 1.34E 06 | 0.00E 00 |
| Co-60   | 1.98E 04 | 2.59E 05 | 0.00E 00 | 1.51E 04 | 0.00E 00 | 0.00E 00 | 8.71E 06 | 0.00E 00 |
| Zn-65   | 6.23E 04 | 4.66E 04 | 3.85E 04 | 1.33E 05 | 8.63E 04 | 0.00E 00 | 1.24E 06 | 0.00E 00 |
| Sr-89   | 1.25E 04 | 3.71E 05 | 4.34E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 2.41E 06 | 0.00E 00 |
| Sr-90   | 6.67E 06 | 7.64E 05 | 1.08E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 1.65E 07 | 0.00E 00 |
| Zr-95   | 3.15E 04 | 1.49E 05 | 1.45E 05 | 4.58E 04 | 6.73E 04 | 0.00E 00 | 2.68E 06 | 0.00E 00 |
| I-131   | 2.64E 04 | 6.48E 03 | 3.54E 04 | 4.90E 04 | 8.39E 04 | 1.46E 07 | 0.00E 00 | 0.00E 00 |
| I-133   | 6.21E 03 | 1.03E 04 | 1.21E 04 | 2.05E 04 | 3.59E 04 | 2.92E 06 | 0.00E 00 | 0.00E 00 |
| I-135   | 3.49E 03 | 6.95E 03 | 3.70E 03 | 9.44E 03 | 1.49E 04 | 6.21E 05 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 5.48E 05 | 9.75E 03 | 5.02E 05 | 1.13E 05 | 3.75E 05 | 0.00E 00 | 1.46E 05 | 0.00E 00 |
| Cs-136  | 1.37E 05 | 1.09E 04 | 5.14E 04 | 1.93E 05 | 1.10E 05 | 0.00E 00 | 1.77E 04 | 0.00E 00 |
| Cs-137  | 3.11E 05 | 8.47E 03 | 6.69E 05 | 8.47E 05 | 3.04E 05 | 0.00E 00 | 1.21E 05 | 0.00E 00 |
| Ba-140  | 3.51E 03 | 2.28E 05 | 5.46E 04 | 6.69E 01 | 2.28E 01 | 0.00E 00 | 2.03E 06 | 0.00E 00 |
| Ce-141  | 2.16E 03 | 1.26E 05 | 2.84E 04 | 1.89E 04 | 8.87E 03 | 0.00E 00 | 6.13E 05 | 0.00E 00 |
| Ce-144  | 2.62E 05 | 8.64E 05 | 4.89E 06 | 2.02E 06 | 1.21E 06 | 0.00E 00 | 1.34E 07 | 0.00E 00 |
| Nb-95   | 5.66E 03 | 9.68E 04 | 1.86E 04 | 1.03E 04 | 1.00E 04 | 0.00E 00 | 7.51E 05 | 0.00E 00 |
| Ru-103  | 8.96E 02 | 1.09E 05 | 2.10E 03 | 0.00E 00 | 7.43E 03 | 0.00E 00 | 7.83E 05 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 24 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Inhalation Pathway Child Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 1.21E 03 | 1.12E 03 | 0.00E 00 | 1.12E 03 | 1.12E 03 | 1.12E 03 | 1.12E 03 | 1.12E 03 |
| Cr-51   | 1.54E 02 | 1.08E 03 | 0.00E 00 | 0.00E 00 | 2.43E 01 | 8.53E 01 | 1.70E 04 | 0.00E 00 |
| Mn-54   | 9.50E 03 | 2.29E 04 | 0.00E 00 | 4.29E 04 | 1.00E 04 | 0.00E 00 | 1.57E 06 | 0.00E 00 |
| Fe-59   | 1.67E 04 | 7.06E 04 | 2.07E 04 | 3.34E 04 | 0.00E 00 | 0.00E 00 | 1.27E 06 | 0.00E 00 |
| Co-58   | 3.16E 03 | 3.43E 04 | 0.00E 00 | 1.77E 03 | 0.00E 00 | 0.00E 00 | 1.10E 06 | 0.00E 00 |
| Co-60   | 2.26E 04 | 9.61E 04 | 0.00E 00 | 1.31E 04 | 0.00E 00 | 0.00E 00 | 7.06E 06 | 0.00E 00 |
| Zn-65   | 7.02E 04 | 1.63E 04 | 4.25E 04 | 1.13E 05 | 7.13E 04 | 0.00E 00 | 9.94E 05 | 0.00E 00 |
| Sr-89   | 1.72E 04 | 1.67E 05 | 5.99E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 2.15E 06 | 0.00E 00 |
| Sr-90   | 6.43E 06 | 3.43E 05 | 1.01E 08 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 1.47E 07 | 0.00E 00 |
| Zr-95   | 3.69E 04 | 6.10E 04 | 1.90E 05 | 4.17E 04 | 5.95E 04 | 0.00E 00 | 2.23E 06 | 0.00E 00 |
| I-131   | 2.72E 04 | 2.84E 03 | 4.80E 04 | 4.80E 04 | 7.87E 04 | 1.62E 07 | 0.00E 00 | 0.00E 00 |
| I-133   | 7.68E 03 | 5.47E 03 | 1.66E 04 | 2.03E 04 | 3.37E 04 | 3.84E 06 | 0.00E 00 | 0.00E 00 |
| I-135   | 4.14E 03 | 4.44E 03 | 4.92E 03 | 8.73E 03 | 1.34E 04 | 7.92E 05 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 2.24E 05 | 3.84E 03 | 6.50E 05 | 1.01E 05 | 3.30E 05 | 0.00E 00 | 1.21E 05 | 0.00E 00 |
| Cs-136  | 1.16E 05 | 4.17E 03 | 6.50E 04 | 1.71E 05 | 9.53E 04 | 0.00E 00 | 1.45E 04 | 0.00E 00 |
| Cs-137  | 1.28E 05 | 3.61E 03 | 9.05E 05 | 8.24E 05 | 2.82E 05 | 0.00E 00 | 1.04E 05 | 0.00E 00 |
| Ba-140  | 4.32E 03 | 1.02E 05 | 7.39E 04 | 6.47E 01 | 2.11E 01 | 0.00E 00 | 1.74E 06 | 0.00E 00 |
| Ce-141  | 2.89E 03 | 5.65E 04 | 3.92E 04 | 1.95E 04 | 8.53E 03 | 0.00E 00 | 5.43E 05 | 0.00E 00 |
| Ce-144  | 3.61E 05 | 3.88E 05 | 6.77E 06 | 2.12E 06 | 1.17E 06 | 0.00E 00 | 1.19E 07 | 0.00E 00 |
| Nb-95   | 6.55E 03 | 3.70E 04 | 2.35E 04 | 9.18E 03 | 8.62E 03 | 0.00E 00 | 6.14E 05 | 0.00E 00 |
| Ru-103  | 1.07E 03 | 4.48E 04 | 2.79E 03 | 0.00E 00 | 7.03E 03 | 0.00E 00 | 6.62E 05 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

Table 25 R<sub>i</sub> Values for the Monticello Nuclear Generating Plant Inhalation Pathway Infant Age Group

| Nuclide | T. Body  | GI Tract | Bone     | Liver    | Kidney   | Thyroid  | Lung     | Skin     |
|---------|----------|----------|----------|----------|----------|----------|----------|----------|
| H-3     | 6.46E 02 | 6.46E 02 | 0.00E 00 | 6.46E 02 | 6.46E 02 | 6.46E 02 | 6.46E 02 | 6.46E 02 |
| Cr-51   | 8.93E 01 | 3.56E 02 | 0.00E 00 | 0.00E 00 | 1.32E 01 | 5.75E 01 | 1.28E 04 | 0.00E 00 |
| Mn-54   | 4.98E 03 | 7.05E 03 | 0.00E 00 | 2.53E 04 | 4.98E 03 | 0.00E 00 | 9.98E 05 | 0.00E 00 |
| Fe-59   | 9.46E 03 | 2.47E 04 | 1.35E 04 | 2.35E 04 | 0.00E 00 | 0.00E 00 | 1.01E 06 | 0.00E 00 |
| Co-58   | 1.82E 03 | 1.11E 04 | 0.00E 00 | 1.22E 03 | 0.00E 00 | 0.00E 00 | 7.76E 05 | 0.00E 00 |
| Co-60   | 1.18E 04 | 3.19E 04 | 0.00E 00 | 8.01E 03 | 0.00E 00 | 0.00E 00 | 4.50E 06 | 0.00E 00 |
| Zn-65   | 3.10E 04 | 5.13E 04 | 1.93E 04 | 6.25E 04 | 3.24E 04 | 0.00E 00 | 6.46E 05 | 0.00E 00 |
| Sr-89   | 1.14E 04 | 6.39E 05 | 3.97E 05 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 2.03E 06 | 0.00E 00 |
| Sr-90   | 2.59E 06 | 1.31E 05 | 4.08E 07 | 0.00E 00 | 0.00E 00 | 0.00E 00 | 1.12E 07 | 0.00E 00 |
| Zr-95   | 2.03E 04 | 2.17E 04 | 1.15E 05 | 2.78E 04 | 3.10E 00 | 0.00E 00 | 1.75E 06 | 0.00E 00 |
| I-131   | 1.96E 04 | 1.06E 03 | 3.79E 04 | 4.43E 04 | 5.17E 04 | 1.48E 07 | 0.00E 00 | 0.00E 00 |
| I-133   | 5.59E 03 | 2.15E 03 | 1.32E 04 | 1.92E 04 | 2.24E 04 | 3.55E 06 | 0.00E 00 | 0.00E 00 |
| I-135   | 2.27E 03 | 1.83E 03 | 3.86E 03 | 7.60E 03 | 8.47E 03 | 6.96E 05 | 0.00E 00 | 0.00E 00 |
| Cs-134  | 7.44E 04 | 1.33E 03 | 3.96E 05 | 7.02E 05 | 1.90E 05 | 0.00E 00 | 7.95E 04 | 0.00E 00 |
| Cs-136  | 5.28E 04 | 1.43E 03 | 4.82E 04 | 1.34E 05 | 5.63E 04 | 0.00E 00 | 1.17E 04 | 0.00E 00 |
| Cs-137  | 4.54E 04 | 1.33E 03 | 5.48E 05 | 6.11E 05 | 1.72E 05 | 0.00E 00 | 7.12E 04 | 0.00E 00 |
| Ba-140  | 2.89E 03 | 3.83E 04 | 5.59E 04 | 5.59E 01 | 1.34E 01 | 0.00E 00 | 1.59E 06 | 0.00E 00 |
| Ce-141  | 1.99E 03 | 2.15E 04 | 2.77E 04 | 1.66E 04 | 5.24E 03 | 0.00E 00 | 5.16E 05 | 0.00E 00 |
| Ce-144  | 1.76E 05 | 1.48E 05 | 3.19E 06 | 1.21E 06 | 5.38E 06 | 0.00E 00 | 9.84E 06 | 0.00E 00 |
| Nb-95   | 3.78E 03 | 1.27E 04 | 1.57E 04 | 4.79E 05 | 4.72E 03 | 0.00E 00 | 4.79E 05 | 0.00E 00 |
| Ru-103  | 6.79E 02 | 1.61E 04 | 2.02E 03 | 0.00E 00 | 4.24E 03 | 0.00E 00 | 5.52E 05 | 0.00E 00 |

\* R<sub>i</sub> values are in units of mRem/yr per μCi/m<sup>3</sup> for inhalation and tritium, and in units of m<sup>2</sup> mRem/yr per μCi/Sec for all others.

|  |                                      |               |
|--|--------------------------------------|---------------|
| <b>MONTICELLO NUCLEAR GENERATING PLANT</b> |                                      | ODCM-05.01    |
| <b>TITLE:</b>                              | <b>GASEOUS EFFLUENT CALCULATIONS</b> | Revision 3    |
|  |                                      | Page 66 of 66 |

Table 26 Table of Radioisotope Constants Used by EBARR

| i  | Isotope | Fission Yield | Decay Constant |
|----|---------|---------------|----------------|
| 1  | Xe-133  | 0.0669        | 0.00000152     |
| 2  | Xe-135  | 0.0630        | 0.0000210      |
| 3  | Kr-85m  | 0.0130        | 0.0000438      |
| 3  | Kr-88   | 0.0356        | 0.00000690     |
| 4  | Kr-87   | 0.0253        | 0.000152       |
| 5  | Xe-138  | 0.0590        | 0.000814       |
| 6  | Kr-90   | 0.0500        | 0.0210         |
| 7  | Xe-139  | 0.0540        | 0.0169         |
| 8  | Kr-89   | 0.0459        | 0.00361        |
| 10 | Xe-137  | 0.0600        | 0.00296        |
| 11 | Xe-135m | 0.00720       | 0.000722       |
| 12 | Kr-83m  | 0.00520       | 0.000103       |
| 13 | Xe-133m | 0.00160       | 0.00000348     |
| 14 | Xe-131m | 0.000170      | 0.000000668    |
| 15 | Kr-85   | 0.00271       | 0.00000000204  |