MONTICELLO NUCLEAR GENERATION PLANT

OFFSITE DOSE CALCULATION MANUAL

(ODCM)

Rev 4

DOCKET NO. 50-263

NORTHERN STATES POWER COMPANY
MINNEAPOLIS, MINNESOTA

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SF ODCM

RECORD OF REVISIONS

Revision No.	Date	Reason for Revision
Original	May 2, 1979	
1	Feb 29, 1980	Incorporation of NRC Staff comments and correction of miscellaneous errors
2	Jul 23, 1982	Incorporation of NRC Staff comments, addition of short term vent dispersion parameters, and addition of Appendices D and E
3	Mar 24, 1983	Change in milk sampling location
4	Dec 12, 1983	Change in milk sampling locations and remove formula for converting $\mu ci/sec$ to mrad/hr for stack and vent wide range gas monitors

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(sec/m^3) from Appendix A, Table A-3. For purge releases, substitute $(\chi/q)_v$, the highest short term dispersion factor from Table A-12.

K_i = The total whole body dose factor due to gamma emissions from noble gas radionuclide "i" $(\text{mrem/year/}\mu\text{Ci/m}^3)$ from Table 3.1-2

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

$$Q_t = \frac{3000}{(\chi/Q)_v \ \sum\limits_{i} (L_i + 1.1 \ M_i)S_i} \qquad (3.1\text{-}3)$$

$L_i + 1.1 \ M_i$ = The total skin dose factor due to emissions from noble gas radionuclide "i" $(\text{mrem/year/}\mu\text{Ci/m}^3)$ from Table 3.1-2.

d. Determine HHSP (the monitor high-high alarm setpoint above background (net μCi/sec)).

NOTE: Use the _lower_ of the Q_t values obtained in Sections 3.1.1.1b and 3.1.1.1c.

HHSP = 0.50 Q_t (3.1-4)

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.

3.1.1.2 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.

a. Determine the "mix" (noble gases and composition) of the gaseous effluent.

(1) 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 3.1-1 source terms may be used if the Stack releases for the previous month were below the lower limits of detection (LLD).

(2) 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.

$$S_i = \frac{A_i}{\sum_i A_i} \qquad (3.1-5)$$

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

b. Determine Q_t (the maximum acceptable total relase rate of all noble gas radionuclides in the gaseous effluent (μCi/sec)) based upon the whole body exposure limit (500 mrem/yr).

$$Q_t = \frac{500}{\sum_i V_i S_i} \qquad (3.1\text{-}6)$$

NOTE: For short-term batch releases (equal to or less than 500 hrs/year) via drywell purging, substitute v_i for V_i in Equation 3.1-6.

V_i = The constant for long-term releases (greater than 500 hrs/year) for noble gas radionuclide "i" accounting for the gamma radiation from the elevated finite plume (mrem/year/μCi/sec) from Table 3.1-2.

v_i = The constant for short-term releases (equal to or less than 500 hrs/year) for noble gas radionuclide "i" accounting for the gamma radiation from the elevated finite plume (mrem/μCi/sec) from Table 3.1-2.

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

$$Q_t = \frac{3000}{\sum_i (L_i (\chi/Q)_s + 1.1\, B_i) S_i} \qquad (3.1\text{-}7)$$

NOTE: For short-term batch releases (equal to or less than 500 hrs/year) via drywell purging, use short-term $(\chi/q)_s$ value and substitute b_i for B_i in Equation 3.1-7.

L_i $(\chi/Q)_s$ + 1.1 B_i = The total skin dose constant for long-term releases (greater than 500 hrs/yr) due to emissions from noble gas radionuclide "i" (mrem/year/μCi/sec) from Table 3.1-2.

L_i $(\chi/q)_s$ + 1.1 b_i = The total skin dose constant for short-term releases (equal to or less than 500 hrs/year) due to emissions from noble gas radionuclide "i" (mrem/year/μCi/sec) from Table 3.1-2.

d. Determine HHSP (the monitor high-high alarm setpoint above background (μCi/sec).

NOTE: Use the <u>lower</u> of the Q_t values obtained in Sections 3.1.1.2b and 3.1.1.2c.

$$HHSP = 0.50 \ Q_t \qquad\qquad (3.1\text{-}8)$$

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.

3.1.2 Accident Monitors

The gross radioactivity in noble gases removed from the main condensor 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 Off-Gas 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 enviroument without treatment. Offgas flow is automatically terminated when this setpoint is reached.

3.1.2.1   Determine Q_t (the maximum acceptable total release rate in μCi/sec of all noble gas radionuclides in the gaseous effluent at the Off-Gas Monitor after a 5-minute decay based on the maximum acceptable total release rate of 2.60E5 μCi/sec after a 30-minute decay).

a.   Determine the off-gas mixture of the gaseous effluent. The off-gas mixture is the fraction of the off-gas noble gas radioactivity caused by each recoil, diffusion, and equilibrium component. The off-gas mixture is determined, monthly, in conjunction with Monticello Technical Specification 4.8.B.5.c.

b.   Determine Q_t based on the off-gas mixture using Table 3.1-3. This table was prepared using a variation of the NSP EBARR computer code (Appendix D).

3.1.2.2   Determine C_t (the maximum acceptable total radioactivity concentration of all noble gas radionuclides in the gaseous effluent (μCi/cc)).

$$C_t = \frac{(2.12\ E\text{-}3)\ Q_t}{f} \qquad (3.1\text{-}9)$$

f = The maximum acceptable effluent flowrate at the point of release (cfm) = 85.5 cfm.

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

$$C.R. = \frac{C_t}{E}$$ (3.1-10)

            E = The detection efficiency of the monitor for noble
            gas radionuclides represented in main condensor
            off-gas (μCi/cc/mR/hr) from Plant Chemistry
            Surveillance procedures.

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

3.1.3 Offgas Storage Tank Maximum Activity

The Technical Specifications limit the maximum activity in each storage
tank 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 3.1-3 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 inleakage rate (cfm) and the
air ejector monitor release rate is used to confirm that the maximum tank
contents limit is not exceeded.

Table 3.1-3 is entered with the offgas mixture (fraction recoil, diffusion,
and equilibrium rounded to one decimal place) and the air inleakage rate

(in cfm determined from the last tank fill time). The resulting tank activity is multiplied by the air ejector monitor reading (converted to µCi/sec) and divided by the maximum permitted air ejector release rate rate of 260,000 µCi/sec. Linear interpolation of air inleakage is used.

As noted earlier, Table 3.1-3 is derived from the EBARR computer program described in Appendix D. It is extremely unlikely that the maximum tank activity limit will be exceeded.

TABLE 5.1-1

MONTICELLO NUCLEAR GENERATING PLANT
RADIATION ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATION

Type of Sample	Code+	Collection Site	Location
River Water	M-8C	Upstream of Plant	0.19mi @ 285°/WNW
River Water	M-9	Downstream of Plant	0.19mi @ 62°/ENE
Drinking Water	M-14	City of Minneapolis	36 mi @ 128°/SE
Well Water	M-10C	Kirchenbauer Farm	11.5 mi @ 323°/NW
Well Water	M-11	City of Monticello	3.2 mi @ 128°/SE
Well Water	M-12	Plant Well #1	0.2 mi @ 267°/W
Well Water	M-13	Hartung Residance	0.3 mi @ 214°/SW
Sediment-River	M-8C	Upstream of Plant	0.19mi @ 285°/WNW
Sediment-River	M-9	Downstream of Plant	0.19mi @ 62°/ENE
Sediment-Shoreline	M-15	Montissippi Park	1.6 mi @ 117°/ESE
Periphyton or Macroinvertebrates	M-8C	Upstream of Plant	0.19mi @ 285°/WNW
	M-9	Downstream of Plant	0.19mi @ 62°/ENE
Fish	M-8C	Upstream of Plant	0.19mi @ 285°/WNW
Fish	M-9	Downstream of Plant	0.19mi @ 62°/ENE
Milk	M-10C	Kirchenbauer Farm	11.5 mi @ 323°/NW
Milk	M-18	Olson Farm	2.5 mi @ 24°/NNE
Milk	M-24	Anderson Farm	3.6 mi @ 308°/NW
Milk	M-26	Peterson Farm	2.3 mi @ 111°/ESE
Milk	M-28	Hoglund Farm	3.8 mi @ 300°/WNW

TABLE 5.1-1 (continued)

MONTICELLO NUCLEAR GENERATING PLANT
RADIATION ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

Type of Sample	Code [a]	Collection Site	Location
Cultivated Crops			
(Leafy Green Veg)	M-10 [c]	Kirchenbauer Farm	11.5 mi @ 323°/NW
	M-27 [c]	Hageman Residence	1.4 mi @ 131°/SE
(Corn)	M-10 [c]	Kirchenbauer Farm	11.5 mi @ 323°/NW
	M-18 [c]	Olson Farm	2.5 mi @ 24°/NNE
(Potatoes)	M-10 [c]	Kirchenbauer Farm	11.5 mi @ 323°/NW
	M-21	Ewing Farm	4.9 mi @ 115°/ESE
Particulates and Radioiodine (air)	M-1 [c]	Air Station M-1	11.1 mi @ 306°/NW
Particulates and Radioiodine (air)	M-2	Air Station M-2	0.8 mi @ 23°/NNE
Particulates and Radioiodine (air)	M-3	Air Station M-3	0.5 mi @ 181°/S
Particulates and Radioiodine (air)	M-4	Air Station M-4	0.9 mi @ 150°/SSE
Particulates and Radioiodines (air)	M-5	Air Station M-5	2.7 mi @ 136°/SE
Direct Radiation(TLD)	M01A	North Boundary Rd.	0.7 mi @ 353°/N
Direct Radiation(TLD)	M02A	North Boundary Rd.	0.8 mi @ 23°/NNE
Direct Radiation(TLD)	M03A	North Boundary Rd.	1.0 mi @ 43°/NE
Direct Radiation(TLD)	M04A	Biology Station Rd.	0.7 mi @ 92°/E
Direct Radiation(TLD)	M05A	Biology Station Rd.	0.6 mi @ 112°/ESE
Direct Radiation(TLD)	M06A	Biology Station Rd.	0.6 mi @ 133°/SE
Direct Radiation(TLD)	M07A	County Rd. 75	0.5 mi @ 158°/SSE
Direct Radiation(TLD)	M08A	County Rd. 75	0.5 mi @ 183°/S
Direct Radiation(TLD)	M09A	County Rd. 75	0.4 mi @ 203°/SSW
Direct Radiation(TLD)	M10A	County Rd. 75	0.3 mi @ 225°/SW
Direct Radiation(TLD)	M11A	County Rd. 75	0.4 mi @ 250°/WSW
Direct Radiation(TLD)	M12A	County Rd. 75	0.7 mi @ 273°/W
Direct Radiation(TLD)	M13A	North Boundary Rd.	1.1 mi @ 317°/NW
Direct Radiation(TLD)	M14A	North Boundary Rd.	0.8 mi @ 338°/NNW

TABLE 5.1-1 (continued)

MONTICELLO NUCLEAR GENERATING PLANT
RADIATION ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

Type of Sample	Code	Collection Site	Location
Direct Radiation(TLD)	M01B	Sherco #1 Air Sta.	4.6 mi @ 02°/N
Direct Radiation(TLD)	M02B	County Rd. 11	4.4 mi @ 17°/NNE
Direct Radiation(TLD)	M03B	County Rd. 73 & 81	4.5 mi @ 49°/NE
Direct Radiation(TLD)	M04B	Sherco #6 Air Sta.	4.2 mi @ 67°/ENE
Direct Radiation(TLD)	M05B	City of Big Lake	4.4 mi @ 87°/E
Direct Radiation(TLD)	M06B	County Rd 14 & 196 St.	4.3 mi @ 116°/ESE
Direct Radiation(TLD)	M07B	Monte Industrial Dr.	4.4 mi @ 135°/SE
Direct Radiation(TLD)	M08B	Dale Larson Res.	4.6 mi @ 162°/SSE
Direct Radiation(TLD)	M09B	Norbert Weinand Farm	4.7 mi @ 180°/S
Direct Radiation(TLD)	M10B	John Reisewitz Farm	4.4 mi @ 206°/SSW
Direct Radiation(TLD)	M11B	Clifford Vanlith Farm	4.2 mi @ 225°/SW
Direct Radiation(TLD)	M12B	Lake Maria St. Park	4.4 mi @ 253°/WSW
Direct Radiation(TLD)	M13B	Bridgewater Sta.	4.1 mi @ 271°/W
Direct Radiation(TLD)	M14B	Richard Anderson Res.	4.5 mi @ 288°/WNW
Direct Radiation(TLD)	M15B	Gary Williamson Res.	4.5 mi @ 308°/NW
Direct Radiation(TLD)	M16B	Sand Plain Research Farm	4.3 mi @ 338°/NNW
Direct Radiation(TLD)	M01S	Floyd Hartung Res.	0.5 mi @ 213°/SSW
Direct Radiation(TLD)	M02S	Edgar Klucas Res.	0.7 mi @ 142°/SE
Direct Radiation(TLD)	M03S	Big Oaks Park	1.3 mi @ 89°/E
Direct Radiation(TLD)	M04S	Pinewood School	2.3 mi @ 132°/SE
Direct Radiation(TLD)	M05S	Roman Greener Res.	2.5 mi @ 112°/ESE
Direct Radiation(TLD)	M06S	Monte Service Center	2.7 mi @ 136°/SE
Direct Radiation(TLD)	M01C	Kirchenbauer Farm	11.5 mi @ 323°/NW

Notes:

* "c" denotes control location. All other locations are indicators.

The letters after numbered TLD's are as follows:

"A" denotes locations in the general area of the site boundary
"B" denotes locations about 4 to 5 miles distance from the plant.
"S" denotes special interest locations.

FIGURE 5.1-1
SAMPLING LOCATIONS
MONTICELLO NUCLEAR GENERATING PLANT
RADIATION ENVIRONMENTAL MONITORING PROGRAM