Docket Nos. 50—245
50—336

License Nos. DPR—21
DPR—65

OFFSITE DOSE CALCULATION MANUAL

MILLSTONE UNIT NO. 1
MILLSTONE UNIT NO. 2

NORTHEAST UTILITIES
BERLIN, CONNECTICUT

AUGUST, 1982

NORTHEAST UTILITIES

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THE CONNECTICUT LIGHT AND POWER COMPANY
THE HARTFORD ELECTRIC LIGHT COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
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August 20, 1982

Docket Nos. 50-245
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Director of Nuclear Reactor Regulation
Attn: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: (1) W. G. Counsil letter to R. A. Clark and D. M. Crutchfield, dated August 12, 1982.

Gentlemen:

Millstone Nuclear Power Station, Unit Nos. 1 and 2
Offsite Dose Calculation Manual

In Reference (1), Northeast Nuclear Energy Company (NNECO) made application for amendments to its operating licenses No. DPR-21 and DPR-65 for Millstone Unit Nos. 1 and 2, respectively, to incorporate the Radiological Effluent Technical Specifications into the Safety Technical Specifications. Reference (1) committed to provide the Offsite Dose Calculation Manual (ODCM), common to both Millstone Units Nos. 1 and 2, under a separate cover.

In fulfillment of that commitment, please find attached the ODCM for the Millstone Nuclear Power Station, Unit Nos. 1 and 2. The ODCM provides the parameters and methodology to be used in calculating offsite doses and effluent monitor setpoints as required by the Radiological Effluent Technical Specifications.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

OFFSITE DOSE CALCULATION MANUAL

FOR THE

MILLSTONE NUCLEAR POWER STATION

UNITS 1 & 2

DOCKETS: No. 50-245
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May 1982

OFFSITE DOSE CALCULATION MANUAL

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A. INTRODUCTION

The purpose of this manual is to provide the parameters and methodology to be used in calculating offsite doses and effluent monitor setpoints at the Millstone Nuclear Power Station. Included are methods for determining maximum individual whole body and organ doses due to liquid and gaseous effluents to assure compliance with the dose limitations in the Technical Specifications. Also included are methods for performing dose projections to assure compliance with the liquid and gaseous treatment system operability sections of the Technical Specifications. The manual also includes the methods used for determining quarterly individual and population doses for inclusion in the Semiannual Radioactive Effluents Release Report.

Another section of this manual discusses the methodology to be used in determining effluent monitor alarm/trip setpoints to be used to ensure compliance with the instantaneous release rate limits in the Technical Specifications.

Additional sections provide supplemental information on environmental sample locations and effluent flow paths.

The bases for some of the factors used in this manual are included as appendices to this manual.

This manual does not include the surveillance procedures and forms required to document compliance with the surveillance requirements in the Technical Specifications. All that is included here is the methodology to be used in performance of the surveillance requirements.

Most of the calculations in this manual have two or three methods given for the calculation of the same parameter. These methods are arranged in order of simplicity and conservatism, Method 1 being the easiest and most conservative. As long as releases remain low, one should be able to use Method 1 as a simple estimate of the dose. If release calculations approach the limit however, more detailed yet less conservative calculations may be used.

At any time a more detailed calculation may be used in lieu of a simple calculation.

This manual is written common to both Units 1 and 2 since some release pathways are shared and there are also site release limits involved. These facts make it impossible to completely separate the two unit calculations.

B. RESPONSIBILITIES

All changes to this manual shall be reviewed by the Site Operations Review Committee prior to implementation.

All changes and their rationale shall be documented in the Semiannual Radioactive Effluent Release Report.

It shall be the responsibility of the Station Superintendent to ensure that this manual is used in performance of the surveillance requirements specified in the Technical Specifications.

C. LIQUID DOSE CALCULATIONS

C.1 Quarterly - Total Body Dose

C.1.a Method 1 - Either Unit

Step 1 - Determine C_F = total gross curies of fission and activation products, excluding tritium and dissolved noble gases, released during the calendar quarter.

Step 2 - Determine C_T = total curies of tritium released during the calendar quarter.

Step 3 - Determine D_{QT} = quarterly dose to the total body in mrem.

$$D_{QT} = 1.4 \times 10^{-2} * C_F + 4.9 \times 10^{-7} * C_T \text{ (See Note 1)}$$

Step 4 - If $D_{QT} > 0.5$ mrem, go to Method 2.

(Note 1) - See Appendix A for derivation of these factors.

C.1.b Method 2 - Either Unit

Step 1 - Determine the following curie release totals for the calendar quarter:

C_{134} = Curies of Cs-134

C_{137} = Curies of Cs-137

C_{58} = Curies of Co-58

C_{60} = Curies of Co-60

C_{59} = Curies of Fe-59

C_T = Curies of H-3

Step 2 - Determine V = total volume of dilution water discharged during the calendar quarter, in gallons. This should include all dilution flow and not just that during periods of discharge.

Step 3 - Determine D_{QT} = quarterly total body dose, in mrem:

$$D_{QT} = 1/V\ (1.9 \times 10^9\ C_{134} + 1.5 \times 10^9\ C_{137} + 1.8 \times 10^8\ C_{58} + 1.6 \times 10^9\ C_{60} + 8.3 \times 10^9\ C_{59} + 3.2 \times 10^4 \times C_T)$$

(See Appendix A for derivation of these factors)

Step 4 - If $D_{QT} > 1.0$ mrem, go to Method 3.

C.1.c Quarterly - Total Body Dose - Method 3 - Either Unit

If the calculated dose using Method 2 is greater than 1 mrem, use the NRC computer code LADTAP to calculate the liquid doses. The use of this code, and the input parameters are given in Radiological Assessment Branch Procedure RAB 4-3, Liquid Dose Calculations - LADTAP.

C.2 Quarterly - Maximum Organ Dose

C.2.a Method 1 - Either Unit

Step 1 - Determine C_F - total gross curies of fission and activation products, excluding tritium and dissolved noble gases, released during the calendar quarter - same as Step C.1.a.

Step 2 - Determine D_{QO} = quarterly dose to the maximum organ in mrem.

$D_{QO} = 0.2\ C_F$ (See Appendix B for derivation of factor)

Step 3 - If $D_{QO} > 2$ mrem, go to Method 2.

C.2.b Method 2 - Either Unit

If the calculated dose using Method 1 is greater than 2 mrem, use the NRC computer code LADTAP to calculate the liquid doses. The use of this code, and the input parameters are given in Radiological Assessment Branch Procedure RAB 4-3, Liquid Dose Calculations - LADTAP.

C.3 Annual - Total Body Dose - Either Unit

Determine D_{YT} = dose to the total body for the calendar year as follows:

$D_{YT} = \Sigma D_{QT}$ where the sum is over the first quarter through the present quarter total body doses.

The following should be used as D_{QT}:

(1) If the detailed quarterly dose calculations required per Section C.6 for the semiannual effluent report are complete for any calendar quarter, use that result.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined in Section C.1.

(3) If $D_{YT} > 3$ mrem and any D_{QT} determined as in Section C.1 was not calculated using Method 3 of that section, recalculate D_{QT} using Method 3 if this could reduce D_{YT} to less than 3 mrem.

C.4 Annual - Maximum Organ Dose - Either Unit

Determine D_{YO} = dose to the maximum organ for the calendar year as follows:

$D_{YO} = \Sigma\ D_{QO}$ where the sum is over the first quarter through the present quarter maximum organ doses.

The following guidelines should be used:

(1) If the detailed quarterly dose calculations required per Section C.6 for the semiannual effluent report are complete for any calendar quarter, use that result.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined in Section C.2.

(3) If different organs are the maximum for different quarters, they may be summed together and D_{YO} can be recorded as a less than value as long as the value is less than 10 mrem.

(4) If $D_{YO} > 10$ mrem and any value used in its determination was calculated as in Section C.2 but not with Method 2, recalculate that value using Method 2 if this could reduce D_{YO} to less than 10 mrem.

C.5 Monthly Dose Projections

C.5.a Total Body & Maximum Organ -Unit 1

Step 1 - Determine D'_{MT} = total body dose from the last typical* previously completed month as calculated per the methods in Section C.1.

Step 2 - Determine D'_{MO} = maximum organ dose from the last typical* previously completed month as calculated per the methods in Section C.2.

Step 3 - Estimate R_1 = ratio of the total estimated volume of liquid batches to be released in the present month to the volume released in the past month.

Step 4 - Estimate R_2 = ratio of estimated primary coolant activity for the present month to that for the past month.

Step 5 - Determine F = factor to be applied to estimate ratio of final curie release if there are expected differences in treatment of liquid waste for the present month as opposed to the past month (e.g., bypass of filters or demineralizers). NUREG-16 or past experience should be used to determine the effect of each form of treatment which will vary. F = 1 if there are no expected differences.

Step 6 - Determine D^E_{MT} = estimated montly total body dose as follows:

$$D^E_{MT} = D'_{MT} * R_1 * R_2 * F$$

Step 7 Determine D^E_{MO} = estimated monthly maximum organ dose as follows:

$$D^E_{MO} = D'_{MO} * R_1 * R_2 * F$$

* - The last typical month should be one without significant operational differences from the projected month.

For example, if the plant was down for refueling the entire month of February and startup is scheduled for March 3, use the last month of operation as the base month to estimate March's dose.

Or, if there were no releases during September, do not use September as the base month for October if it is estimated that there will be releases in October.

C.5.b Total Body + Maximum Organ -Unit 2

Step 1 - Determine D'_{MT} = total body dose from the last typical* previously completed month as calculated per the method in Section C.1.

Step 2 - Determine D'_{MO} = maximum organ dose from the last typical* previously completed month as calculated per the methods in Section C.2.

* - See footnote in Section C.5.a.

Step 3 - Estimate R_1 = ratio of the total estimated volume of liquid batches to be released in the present month to the volume released in the past month.

Step 4 - Estimate R_2 = ratio of the total estimated volume of steam generator blowdown to be released in present month to the volume released in the past month.

Step 5 - Estimate F_1 = fraction of curies released last month coming from steam generator blowdown.

i.e.) $$F_1 = \frac{\text{curies from blowdown}}{\text{curies from blowdown + curies from batch tanks}}$$

Step 6 - Estimate R_3 = ratio of estimated secondary coolant activity for the present month to that for the past month.

Step 7 - Estimate R_4 = ratio of estimated primary coolant activity for the present month to that for the past month.

Step 8 - Determine F_2 = factor to be applied to estimate ratio of final curie release if there are expected differences in treatment of liquid waste for the present month as opposed to the past month (e.g., bypass of filters or demineralizers). NUREG-17 or past experience should be used to determine the effect of each form of treatment which will vary. F_2 = 1 if there are no expected differences.

Step 9 - Determine D^E_{MT} = estimated monthly total body dose as follows:

$$D^E_{MT} = D'_{MT} \left[(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3\right]$$

Step 10 - Determine D^E_{MO} = estimated monthly maximum organ dose as follows:

$$D^E_{MO} = D'_{MO} \left[(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3\right]$$

C.6 Quarterly Dose Calculations for Semi-Annual Radioactive Effluent Report

Detailed quarterly dose calculations required for the semi-annual Radioactive Effluent Report shall be done using the NRC computer code LADTAP. The use of this code, and the input parameters are given in Radiological Assessment Branch Procedure RAB 4-3, Liquid Dose Calculations - LADTAP.

D. GASEOUS DOSE CALCULATIONS

D.1 10CFR20 Limits ("Instantaneous")

D.1.a Instantaneous Noble Gas Release Rate Limits - Both Units

The instantaneous noble gas release rate limit from the site shall be:

$$\frac{Q_1}{830,000} + \frac{Q_2}{260,000} \leq 1$$

where

Q_1 = Noble gas release rate from MP1 stack (μCi/sec)

Q_2 = Noble gas release rate from MP2 vent (μCi/sec)

See Appendix D for derivation of this limit.

As long as the above is ≤ 1, the doses will be ≤ 500 mrem to the total body and ≤ 3000 mrem to the skin.

D.1.b Release Rate Limit - I-131, Particulates With Half Lives Greater Than 8 Days, and Radionuclides Other Than Noble Gases With Half Lives Greater Than 8 Days - Both Units

(1) The release rate limit of I-131 and tritium from the site shall be:

$$\frac{Q_{I1}}{10.6} + \frac{Q_{I2}}{0.58} + \frac{Q_{T1}}{4.3 \times 10^6} + \frac{Q_{T2}}{4.0 \times 10^4} \leq 1 \text{ where,}$$

Q_{I1} = Release rate of I-131 from MP1 Stack - (μCi/sec)

Q_{I2} = Release rate of I-131 from MP2 Stack - (μCi/sec)*

Q_{T1} = Release rate of tritium from MP1 Stack - (μCi/sec)

Q_{T2} = Release rate of tritium from MP2 Stack - (μCi/sec)*

(2) The release rate limit for particulates with half lives greater than 8 days and tritium from the site shall be:

$$\frac{Q_1}{122} + \frac{Q_2}{3.5} + \frac{Q_{T1}}{4.3 \times 10^6} + \frac{Q_{T2}}{4.0 \times 10^4} \leq 1 \text{ where,}$$

Q_1 = Release rate of total particulates with half lives greater than 8 days from the MP1 Stack (μCi/sec).

Q_2 = Release rate of total particulates with half lives greater than 8 days from the MP2 Stack (μCi/sec).

Q_{T1} = Release rate of tritium from MP1 Stack - (μCi/sec)

Q_{T2} = Release rate of tritium from MP2 Stack - (μCi/sec)*

With releases within the above limits, the dose rate to the maximum organ will be less than 1500 mrem/year.

*Includes releases via the steam generator blowdown tank vent.

D.2 Appendix I Noble Gas Limits

D.2.a Quarterly Air Dose - Method 1 - Both Units

Step 1 - Determine C_{N1} = Total curies of noble gas released from Unit 1 during the calendar quarter.

Step 2 - Determine C_{N2} = Total curies of noble gas released from Unit 2 during the calendar quarter. Include all sources - ventilation, containment purges, and waste gas tanks.

Step 3 - Determine D_{QG1} = Quarterly gamma air dose from Unit 1 (mrad).

$$D_{QG1} = 4.8 \times 10^{-5} \, C_{N1} \, *$$

Step 4 - Determine D_{QB1} = quarterly beta air dose from Unit 1 (mrad).

$$D_{QB1} = 4.8 \times 10^{-7} \, C_{N1} \, *$$

Step 5 - Determine D_{QG2} = quarterly gamma air dose from Unit 2 (mrad).

$$D_{QG2} = 1.8 \times 10^{-4} \, C_{N2} \, *$$

Step 6 - Determine D_{QB2} = quarterly beta air dose from Unit 2 (mrad).

$$D_{QB2} = 5.9 \times 10^{-4} \, C_{N2} \, *$$

Step 7 - If D_{QG1} or $D_{QG2} > 2.5$ mrad; or D_{QB1} or $D_{QB2} > 5$ mrad, go to Method 2.

*See Appendix D for derivation of factors.

D.2.b Quarterly Air Dose - Method 2 - Both Units

Unit 2 - For MP2 dose calculations use the GASPAR computer code to determine the critical site boundary air doses.

For the Special Location, enter the following worst case quarterly average meteorology:

$X/Q = 0.13 \times 10^{-4}$ sec/m^3

$D/Q = 0.15 \times 10^{-6}$ m^{-2}

(See Appendix D)

If the calculated air dose exceeds the Tech Spec limit use real time meterology.

Unit 1 - For MP1 dose calculations use the AIREM computer code to determine the critical location air doses.

The 3rd quarter 1978 joint frequency data should be used as input for the AIREM code. The reason for this is given in Appendix D.

If the calculated air dose exceeds the Tech Spec limit, use real time meteorology.

D.2.c Annual Air Dose Limit Due to Noble Gases - Both Units

Determine D_{YG1}, D_{YG2}, D_{YB1} and D_{YB2} = gamma air dose and beta air dose for the calender year for Unit 1 or 2 as follows:

$$D_{YG1} = \Sigma D_{QG1},\ D_{YB1} = \Sigma D_{QB1} \text{ and } D_{YG2} = \Sigma D_{QG2},\ D_{YB2} = \Sigma D_{QB2}$$

where the sum is over the first quarter through the present quarter doses.

The following should be used as the quarterly doses:

(1) If the detailed quarterly dose calculations required per the section for the semi-annual effluent report are complete for any calendar quarter, use those results.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined above in Section D.2.a or D.2.b.

(3) If $D_{YG1 \text{ or } 2} > 10$ mrad or $D_{YB1 \text{ or } 2} > 20$ mrad and any corresponding quarterly dose was not calculated using Section D.2.b - real time meteorology, recalculate the quarterly dose using real time meteorology.

D.3 Appendix I - Iodine and Particulate Doses

D.3.a Quarterly Doses - Unit 1

(1) Method 1 - Unit 1

Step 1 - Determine C_I = total curies of I-131 released in gaseous effluents from Unit 1 during the quarter.

Step 2 - Determine C_P = total curies of particulates with half lives greater than 8 days released in gaseous effluents from Unit 1 during the calendar quarter.

Step 3 - Determine D_{QT} = quarterly thyroid dose as follows:

$D_{QT} = 8.4\ C_I$ (See Appendix D)

Step 4 - Determine D_{QO} = quarterly dose to the maximum organ other than the thyroid:

$D_{QO} = 1.1\ C_P$ (See Appendix D)

Step 5 - The maximum organ dose is the greater of D_{QT} or D_{QO}. If it is greater than 5 mrem, go to Method 2.

(2) Method 2 - Unit 1

Use the GASPAR code to determine the maximum organ dose. For the Special Location, enter the following worst case quarterly average meteorology as taken from Appendix D:

$X/Q = 7.1 \times 10^{-8}\ SEC/M^3$

$D/Q = 7.9 \times 10^{-9}\ M^{-2}$

Use the goat milk, vegetation and inhalation pathway in totaling the dose. If the maximum organ dose is greater than 7.5 mrem, go to Method 3.

(3) Method 3 - Unit 1

Use the GASPAR code with actual locations, real-time meteorology and the pathways which actually exist at the time at those locations.

D.3.b Quarterly Doses - Unit 2

(1) Method 1

Step 1 - Determine C_I = total curies of I-131 released in gaseous effluents from Unit 2 during the quarter.

Step 2 - Determine C_P = total curies of particulates with half lives greater than 8 days released in gaseous effluents from Unit 2 during the calendar quarter.

Step 3 - Determine C_T = total curies of tritium released in gaseous effluents from Unit 2 during the calendar quarter.

Step 4 - Determine D_{QT} = quarterly thyroid dose as follows:

$$D_{QT} = 250\ C_I + 1.8 \times 10^{-3}\ C_T \text{ (See Appendix D)}$$

Step 5 - Determine D_{QO} = quarterly dose to the maximum organ other than the thyroid:

$$D_{QO} = 55\ C_P + 1.8 \times 10^{-3}\ C_T \text{ (See Appendix D)}$$

Step 6 - The maximum organ dose is the greater of D_{QT} or D_{QO}. If greater than 5 mrem, go to Method 2.

(2) Method 2

Use the GASPAR code to determine the maximum organ dose. For the Special Location, enter the following worst case quarterly average meteorology as taken from Appendix D:

$$X/Q = 0.13 \times 10^{-4} \text{ sec}/M^3$$

$$D/Q = 0.15 \times 10^{-6}\ M^{-2}$$

As shown in Appendix D, the same meteorology can be used for both continuous and batch releases. Therefore, the program need only be run once using the total curies from all releases from Unit 2.

Use the goat milk, vegetation and inhalation pathways in totaling the dose. If the maximum organ dose is greater than 7.5 mrem, go to Method 3.

(3) Method 3 - Unit 2

Use the GASPAR code with actual locations, real-time meteorlogy and the pathways which actually exist at the time at these locations. The code should be run separately for steam generator blowdown tank vents and ventilation releases, containment purges and waste gas tank releases.

D.3.c Maximum Organ - Annual Doses - Both Units

Determine D_{YO1} and D_{YO2} = maximum organ dose for the calendar year for Units 1 and 2 respectively as follows:

$D_{YO1 \text{ or } 2} = \Sigma D_{QO}$ = sum of quarterly maximum organ doses where the sum is over the first quarter through the present quarter doses.

The following guidelines should be used for use of D_{QO}:

(1) If the detailed quarterly dose calculations required per the section for the semi-annual effluent report are complete for any calendar quarter, use those results.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined above in Section D.3.a or D.3.b.

(3) If D_{YO} is greater than 15 mrem and any quarterly dose was not calculated using Method 3 of Section D.3.a or D.3.b, recalculate the quarterly dose using Method 3.

(4) If different organs are the maximum organ for different quarters, they can be summed together and D_{YO} recorded as a less than value as long as the value is less than 15 mrem. If it is not, the sum for each organ involved should be determined.

D.4 Gaseous Effluent Monthly Dose Projections

D.4.a Unit 1

(1) Due to Gaseous Radwaste Treatment System (Offgas)

Step 1 - If it is expected that the augmented offgas treatment system will be out of service during the month, go to Step 7. Otherwise, continue with Steps 2 through 6.

Step 2 - Determine C'_N = number of curies of noble gas released during the most recent month of operation from the augmented offgas system.

Step 3 - Estimate R_1 = ratio of expected full power offgas rate at the air ejector for the upcoming month compared to the reference month of Step 2.

Step 4 - Estimate R_2 = ratio of expected unit production capacity for the upcoming month compared to the reference month of Step 2.

Step 5 - Determine D^E_{MG} = estimated monthly gamma air dose.

D^E_{MG} (mrad) = 4.8×10^{-5} C'_N R_1 R_2 (Factor is from Appendix D)

Step 6 - Determine D^E_{MB} = estimated monthly beta air dose.

$D^E_{MB} = 4.8 \times 10^{-7}$ C'_N R_1 R_2 (Factor is from Appendix D)

Step 7 - If the augmented offgas system is expected to be out of service during the month, determine the following:

Q = Estimated curies/sec at the air ejector at expected maximum power for the month.

R = estimated curie reduction factor from air ejector to stack via 30 minute holdup line (in decimal fraction).

d = estimated number of days 30 minute holdup pipe will be used.

D^E_{MG} = estimated monthly gamma air dose.

= 4.8×10^{-5} mrad/Ci x Q Ci/sec x R x d (day) x 8.6×10^{4} sec/day.

D^E_{MG} = 4 x Q x R x d

D^E_{MB} = estimated monthly beta air dose.

D^E_{MB} = $0.04 \times Q \times R \times d$

(2) Due to Ventilation System Releases

Step 1 - For the last quarter of operation, determine D_{QT} or D_{QO}* as determined per Section D.3.a.**

Step 2 - Estimate R_1 = expected ratio of primary coolant iodine level for the coming month as compared with the average level during the quarter used in Step 1.

Step 3 - Estimate R_2 = expected ratio of primary leakage rate for the coming month as compared with the average leakage rate during the quarter used in Step 1.

Step 4 - Determine D^E_{MO} = estimated monthly dose to the maximum organ.

$$D^E_{MO} = 1/3\ R_1\ R_2\ D_{QO}\ (\text{or } D_{QT})^*$$

* - Whichever was greater
** - Section D.3.b for Unit 2

D.4.b Unit 2

(1) Due to Gaseous Radwaste Treatment System

Step 1 - Estimate C_N^E = the number of curies of noble gas to be released from the waste gas storage tanks during the next month.

Step 2 - Determine D_{MG}^E = estimated monthly gamma air dose.

$$D_{MG}^E \text{ (mrad)} = 4.8 \times 10^{-5}\ C_N^E$$

(Factor is from Appendix D for the Unit 1 stack releases since the Unit 2 waste gas tanks are discharged via the Unit 1 stack. This factor should be conservative as the isotopic mix would only be the longer lived noble gases which would have lower dose conversion factors than the typical mix from Unit 1.)

Step 3 - Determine D_{MB}^E = estimated monthly beta air dose.

$$D_{MB}^E \text{ (mrad)} = 4.8 \times 10^{-7}\ C_N^E$$

(2) Due to Steam Generator Blowdown Tank Vents and Ventilation Releases

Use the same method as given in Section D.4.a.(2) for Unit 1.

D.5 Quarterly Dose Calculations for Semi-Annual Report

Detailed quarterly dose calculations required for the Semi-Annual Radioactive Effluent Report shall be done using the computer codes GASPAR and AIREM.

D.6 Compliance with 40CFR190

The following sources should be considered in determining the total dose to a real individual from uranium fuel cycle sources:

a) Gaseous Releases from Units 1 and 2

b) Liquid Releases from Units 1 and 2

c) Direct Radiation from the Site

d) Since all other uranium fuel cycle sources are greater than 5 miles away, they need not be considered.

E. LIQUID MONITOR SETPOINTS

E.1 Unit 1 Liquid Radwaste Effluent Line

The trip/alarm setting on the liquid radwaste discharge line depends on dilution water flow, radwaste discharge flow, the isotopic composition of the liquid, the background count rate of the monitor and the efficiency of the monitor. Due to the variability these parameters, an alarm/trip setpoint will be determined prior to the release of each batch. The following methodology will be used:

Step 1 - From the tank isotopic analysis and the MPC values for each identified nuclide (including noble gases) determine the required reduction factor, i.e.:

$$R = \text{Reduction Factor} = 1/\sum_i \frac{\mu Ci/ml \text{ of nuclide } i}{MPC \text{ of nuclide } i}$$

Step 2 - Determine the existing dilution flow = D = #CIRC pumps x 100,000 gpm + # service water pumps x 10,000 gpm.

Step 3 - Determine the allowable discharge flow = F

$F = 0.1 \times R \times D$

Note that discharging at this flow rate would yield a discharge concentration 10% of the Tech Spec Limit due to the safety factor of 0.1.

Step 4 - Determine the total μCi/ml in the tank.

Step 5 - Using the latest monitor calibration curve, determine the "cps" corresponding to two times the total μCi/ml determined in Step 4. This will be the trip setpoint.

Note: If discharging at the allowable discharge rate as determined in Step 3, this would yield a discharge concentration 20% of the Tech Spec limit.

Step 6 - The allowable discharge flow rate calculated in Step 3 may be increased by up to a factor of 5 with appropriate administrative controls.

E.2 Unit 1 Service Water Effluent Line

The M1 Service Water Monitor Hi alarm setting is approximately 1.5 times the ambient background and the Hi-Hi Alarm is approximately 2 times the ambient background reading on the monitor in counts per second.

E.3 Unit 2 Clean Liquid Radwaste Effluent Line

Same as Section E.1 for the MP1 Liquid Radwaste Monitor except for Step 2 where:

Dilution Flow = D #CIRC Pumps x 135,000 gpm + # Service Water Pumps x 4,000 gpm.

E.4 <u>M2 Aerated Liquid Radwaste Effluent Line and Condensate Polishing Facility Waste Neut. Sump</u>

Same as E.3 for Clean Liquid Monitor, except that for the Condensate Polishing Facility Waste Neut. Sump, the monitor has a digital readout of μCi/ml and the alarm setpoint is set directly on μCi/ml and not the corresponding count rate.

E.5 Unit 2 Steam Generator Blowdown Monitor

Maximum possible total S.G. blowdown flow rate = 250 gpm

Minimum possible circ water dilution flow during periods of blowdown = 270,000 gpm (2 pumps)

Unidentified MPC for unrestricted area = 1×10^{-7} µCi/ml*

Therefore, the alarm setpoint should correspond to a concentration of:

$$\text{Alarm } (\mu Ci/ml) = \frac{270,000}{250} \times 1 \times 10^{-7} = 1.1 \times 10^{-4} \ \mu Ci/ml$$

The latest monitor calibration curve should be used to determine the alarm setpoint in cpm corresponding to 1.1×10^{-4} µCi/ml.

This setpoint may be increased through proper administrative controls if the steam generator blowdown rate is maintained less than 250 gpm and/or more than 2 circulating water pumps are available. The percent increase would correspond to the ratio of the flows to those assumed above or:

$$\text{Alarm } (\mu Ci/ml) = 1.1 \times 10^{-4} \ \mu Ci/ml \times \frac{\text{\# Circ water pumps}}{2} \times \frac{250}{\text{S/G Blowdown (gpm)}}$$

$$= \frac{1.4 \times 10^{-2} \ \mu Ci/ml \times \text{\# Circ water pumps}}{\text{total S/G Blowdown (gpm)}}$$

Note: The Steam Generator Blowdown alarm criteria is in practice based on setpoints required to detect allowable levels of primary to secondary leakage. This alarm criteria is typically more restrictive than that required to meet discharge limits. This fact should be verified however whenever the alarm setpoint is recalculated.

*In lieu of using the unidentified MPC value, the identified MPC values for unrestricted areas may be used.

E.6 Unit 2 Condenser Air Ejector Monitor

This monitor is included as a liquid monitor since the reason it's in the Technical Specifications is for control of the Steam Generator Blowdown liquid activity. It can be used in conjunction with or in place of the blowdown monitor to ensure that the blowdown concentration is within 10CFR20 limits.

Gaseous release limits are not controlled by this monitor but rather by the monitor at the final discharge point.

A detailed study was performed to determine the equilibrium steam generator blowdown activity as a function of blowdown rate and primary to secondary leakage rate. It turns out that in order to reach 10CFR20 limits as determined in Section E-5 the minimum primary to secondary leakage rate required is 0.4 gpm. The air ejector monitor is set to alarm at a level corresponding to approximately 0.2 gpm leakage. Thus it ensures adequate control of blowdown. The above values are for the primary coolant activity level used at the time of the study. However, if the coolant activity increased such that the leakage rate required to reach 10CFR20 limits was less, there would be an equal increase in the sensitivity of the air ejector monitor.

E.7 Unit 2 Reactor Bldg. Closed Cooling Water Monitor

The alarm setting is approximately 2 times the ambient background reading of the monitor.

F. GASEOUS MONITOR SETPOINTS

F.1 Unit 1 Hydrogen Monitor

Per Section 3.8.D.6 of the Technical Specifications, the alarm setpoint shall be $\leq$ 4% hydrogen by volume.

F.2 Unit 1 Steam Jet Air Ejector Offgas Monitor

Per Section 3.8.D.7 of the Technical Specifications, the maximum allowed noble gas in-process activity rate shall not exceed 1.47×10^6 µCi/sec. This value will be more limiting than the instantaneous stack release rate limit.

Using the latest offgas monitor calibration curve, determine the reading in mR/HR corresponding to 1.47×10^6 µCi/sec. The alarm setpoint should be set at less than or equal to this value.

F.3 Unit 1 Stack Noble Gas Monitor

Per Technical Specification 3.8.D.1 and ODCM Section D.1.a, the instantaneous release rate limit from the site shall be:

$$\frac{Q_1}{830,000} + \frac{Q_2}{260,000} \leq 1$$

where Q_1 = noble gas release rate from MP1 stack (μCi/sec)

Q_2 = noble gas release rate from MP2 (μCi/sec)

Assume 50% of the limit is from MP1 stack.

Therefore Q_1 should be less than 415,000 μCi/sec.

The MP1 stack noble gas monitor calibration curve (given as μCi/sec per cps) is determined by assuming a maximum ventilation flow of 170,000.

Therefore, the alarm setpoint should be set at or below the "cps" corresponding to 415,000 μCi/sec from the calibration curve.

The alarm setpoint may be increased if the MP2 stack setpoint is at a level corresponding to less than 50% of the site limit.

F.4 Unit 1 Main Stack Sampler Flow Rate Monitor

The MP1 main stack sampler flow control alarms on low pressure indicating loss of flow, or on high pressure indicating restricted flow.

The alarm will occur with either:

a) Pressure Switch #1 < 2" Hg

or

b) Pressure Switch #1 > 18" Hg and Pressure Switch #2 < 20" Hg

F.5 Unit 2 Vent - Noble Gas Monitor

Per Section D.1.a of this manual, the instantaneous release rate limit from the site shall be:

$$\frac{Q_1}{830,000} + \frac{Q_2}{260,000} \leq 1$$

Assuming 50% of the limit is from the MP2 vent, the release rate limit for Unit 2 is 130,000 μCi/sec.

The MP2 vent noble gas monitor calibration curve (given as μCi/sec per cpm) is determined by assuming the maximum possible ventilation flow for various fan combinations. Curves for 3 different fan combinations are normally given.

The "cpm" corresponding to 130,000 μCi/sec should be determined from the appropriate curve. The alarm setpoint should be set at less than or equal to this value.

The alarm setpoint may be increased if the MP1 stack setpoint is at a level corresponding to less than 50% of the site limit.

F.6 Unit 2 Waste Gas Decay Tank Monitor

Per Section D.1.a of this manual, the instantaneous release rate limit from the site shall be:

$$\frac{Q_1}{830{,}000} + \frac{Q_2}{260{,}000} \leq 1$$

Administratively all waste gas decay tank releases are via the MP1 stack. Assuming 50% of the limit is from the MP1 stack, the release rate limit for MP1 is 415,000 μCi/sec.

Releases from waste gas decay tanks are much lower than this limit and are based upon ventilation dilution, conservative meteorology ($\chi/Q = 10^{-3}$) and release flow rates to maintain off site concentration below MPC values.

The MP2 waste gas decay tank monitor (given as μCi/cc per cpm) calibration curve is used to assure that the concentration of gaseous activity being released from a waste gas decay tank is not greater than the concentration used in discharge permit calculations.

G. ENVIRONMENTAL MONITORING PROGRAM

SAMPLING LOCATIONS

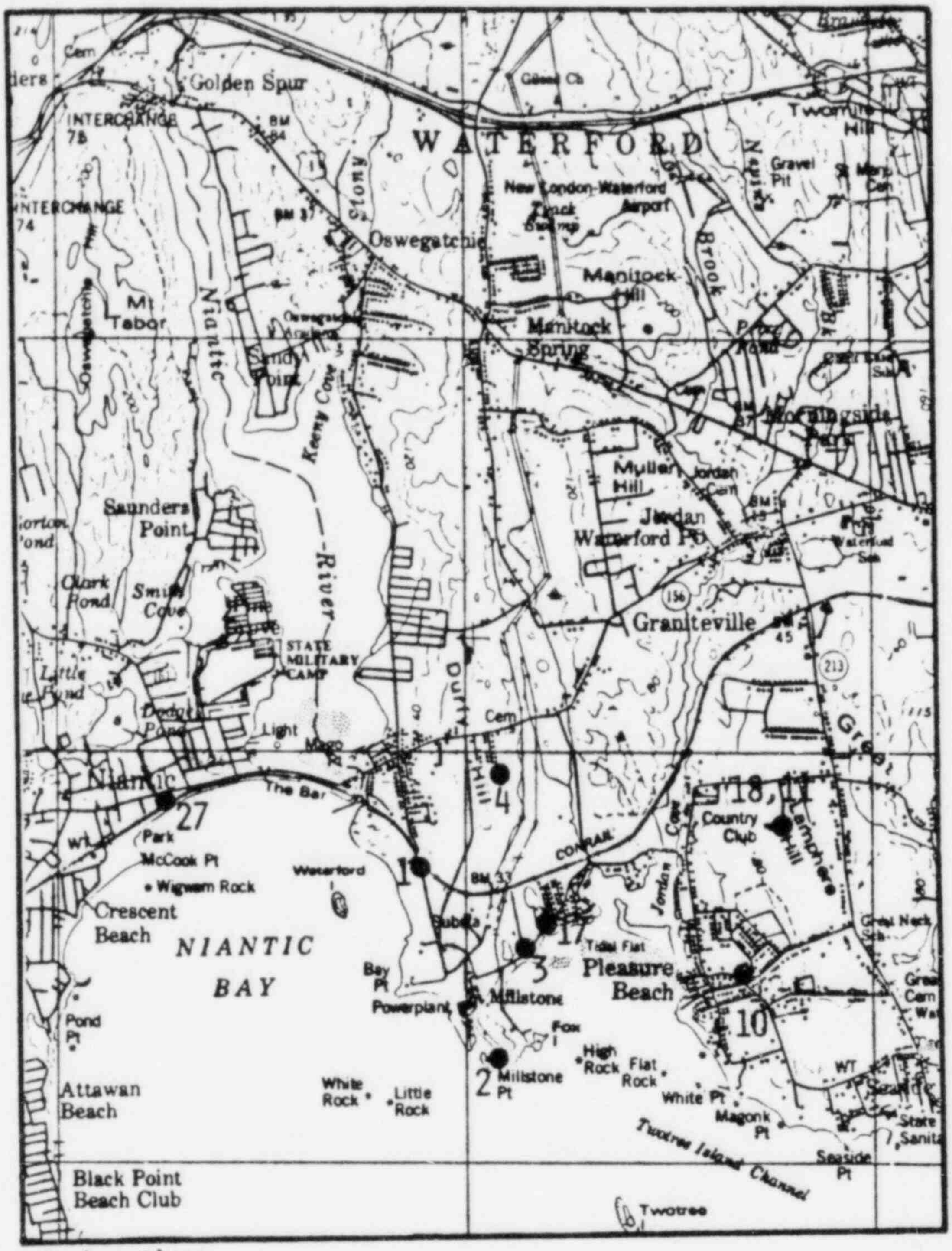
The following lists the environmental sampling locations and the types of samples obtained at each location. Sampling locations are also shown on Figures G-1, G-2 and G-3.

Location Number	Location Name	Direction & Distance From Release Point**	Sample Types
1-I*	Onsite - Old Millstone Rd.	0.6 Mi. - NNW	TLD, Air Particulate, Iodine
2-I	Onsite - Weather Shack	0.3 Mi. - SSE	TLD, Air Particulate, Iodine
3-I	Onsite - Bird Sanctuary	0.3 Mi. - NE	TLD, Air Particulate, Iodine
4-I	Onsite - Albacore Drive	1.0 Mi. - N	TLD, Air Particulate, Iodine
5-I	Floating Barge	0.2 Mi. - SSE	TLD
6-I	Quarry Discharge	0.3 Mi. - SSE	TLD
7-I	Fox Island	0.3 Mi. - ESE	TLD
8-I	Millstone Environmental Lab	0.3 Mi. - SE	TLD
9-I	Bay Point Beach	0.4 Mi. - W	TLD
10-I	Pleasure Beach	1.4 Mi. - E	TLD, Air Particulate, Iodine
11-I	New London Country Club	1.6 Mi. - ENE	TLD, Air Particulate, Iodine
12-C	Fisher's Island, NY	8.7 Mi. - ESE	TLD
13-C	Mystic, CT	12.0 Mi. - ENE	TLD
14-C	Ledyard, CT	12.0 Mi. - NE	TLD
15-C	Montville, CT	14.0 Mi. - N	TLD, Air Particulate, Iodine
16-C	Old Lyme, CT	8.5 Mi. - W	TLD
17-I	Site Boundary	0.5 Mi. - NE	Vegetation
18-I	New London Country Club	1.6 Mi. - ENE	Vegetation
19-I	Cow Location #1	4.5 Mi. - WNW	Milk
20-I	Cow Location #2	7.5 Mi. - W	Milk
21-I	Cow Location #3	11.5 Mi. - NE	Milk
22-C	Cow Location #4	16.0 Mi. - NNW	Milk
23-I	Goat Location #1	2.0 Mi. - ENE	Milk
24-C	Goat Location #2	14.0 Mi. - NE	Milk
25-I	Fruits & Vegetables	Within 10 Miles	Vegetation
26-C	Fruits & Vegetables	Beyond 10 Miles	Vegetation
27-I	Niantic	1.7 Mi. - WNW	TLD, Air Particulate, Iodine
28-I	Two Tree Island	0.8 Mi. - SSE	Mussels
29-I	Jordan Cove	0.4 Mi. - NNE	Clams
30-C	Golden Spur	4.7 Mi. - NNW	Bottom Sediment
31-I	Niantic Shoals	1.8 Mi. - NW	Bottom Sediment, Oysters
		1.5 Mi. - NNW	Mussels
32-I	Vicinity of Discharge		Bottom Sediment, Oysters, Lobster, Fish, Seawater
33-I	Seaside Point	1.8 Mi. - ESE	Bottom Sediment
34-I	Thames River Yacht Club	4.0 Mi. - ENE	Bottom Sediment
35-I	Niantic Bay	0.3 Mi. - W	Lobster, Fish
36-I	Black Point	3.0 Mi. - WSW	Bottom Sediment, Oysters

Location Number	Name	Direction & Distance From Release Point**	Sample Types
37-C	Giant's Neck	3.5 Mi. - WSW	Bottom Sediment, Oysters, Lobster, Seawater
38-I	Waterford Shellfish Bed #1	1.5 Mi. - NNW	Clams

*I = Indicator C = Control

**For terrestial locations, this is the MP1 stack, for aquatic it is the quarry cut.



● Locations
Scale: 1 inch equals 0.78 mile

Figure G-1

Inner Air Particulate and Vegetation Monitoring Stations
Millstone Nuclear Power Station

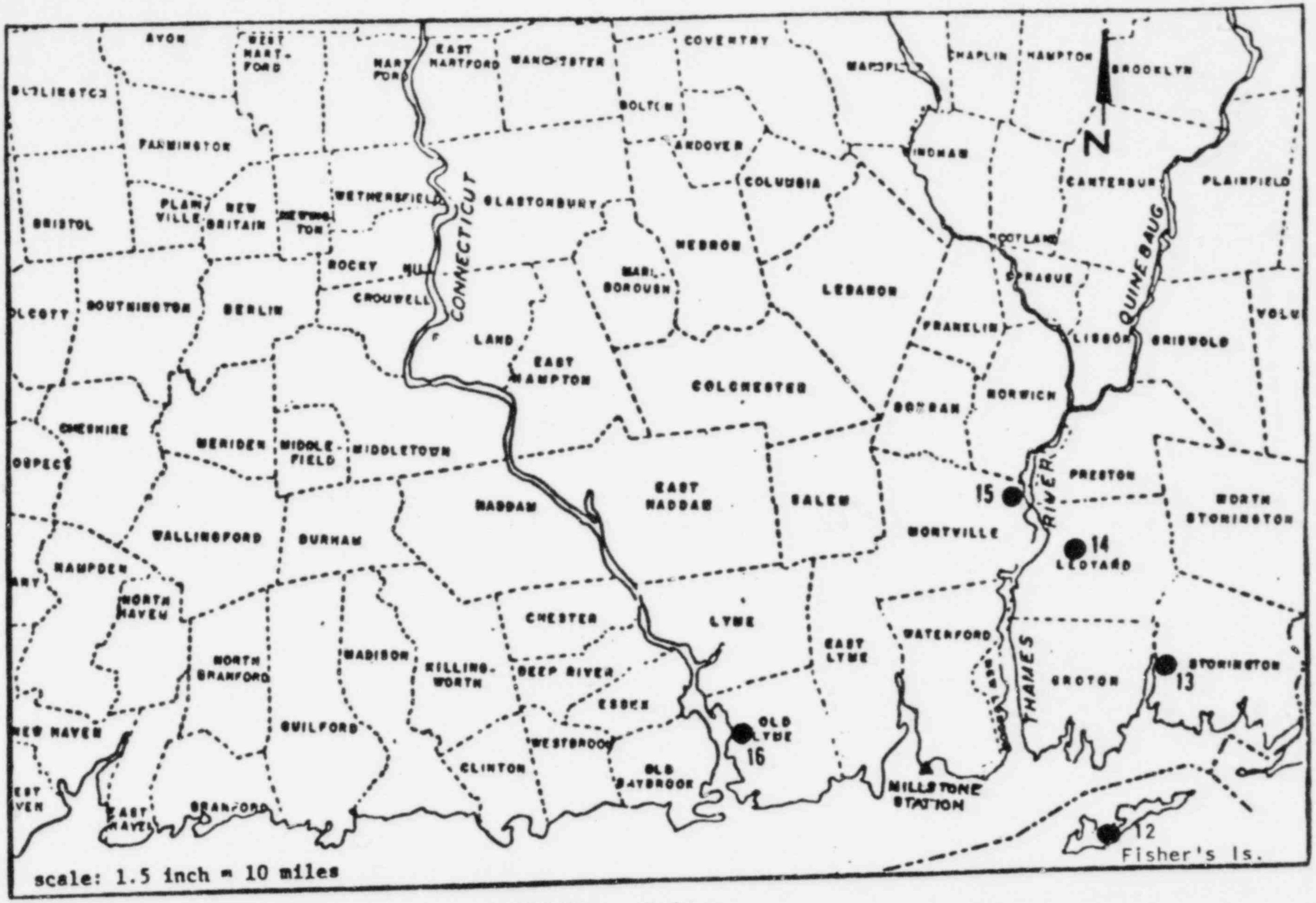


FIGURE G-2
Outer Terrestrial Monitoring Stations
Millstone Nuclear Power Station

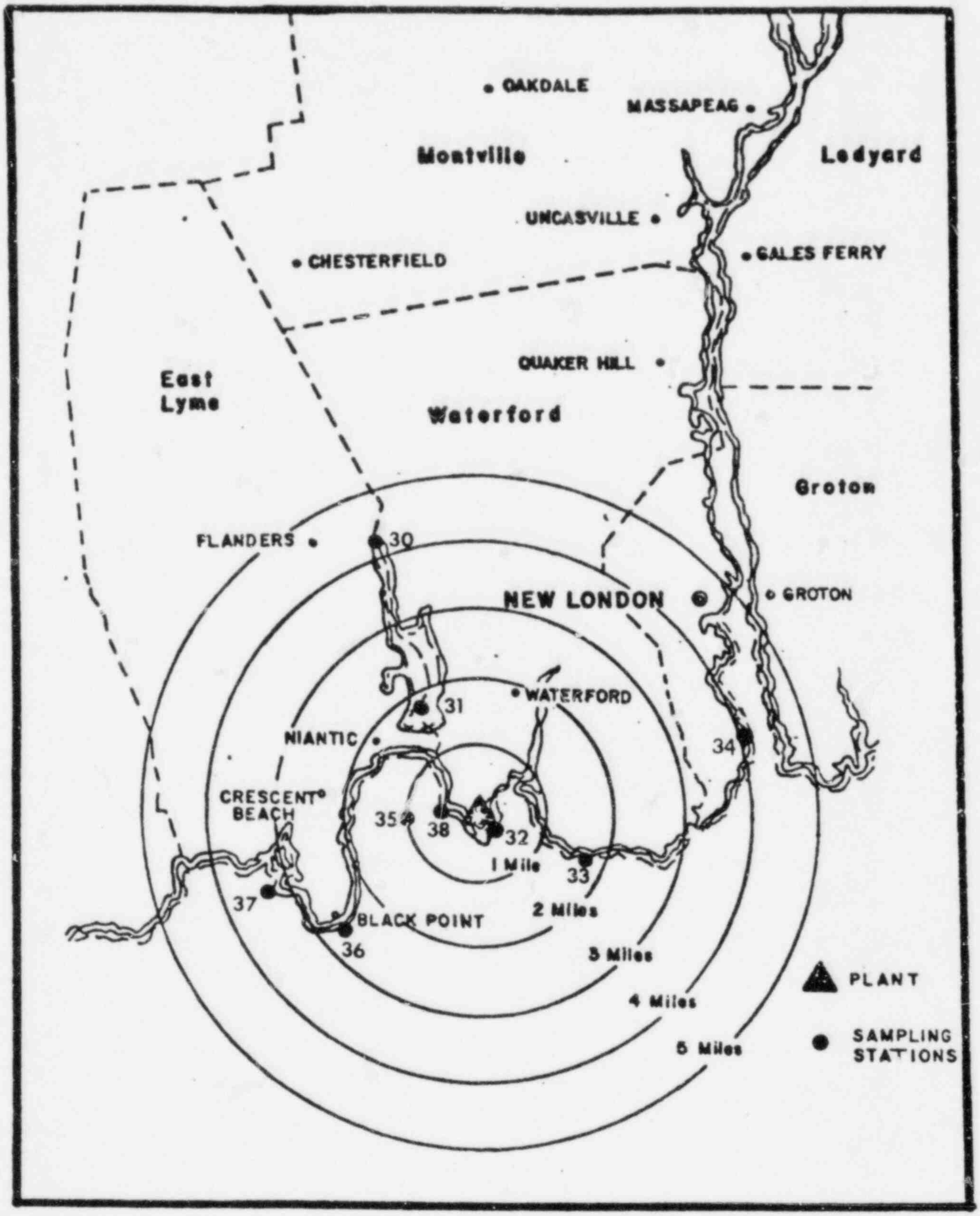
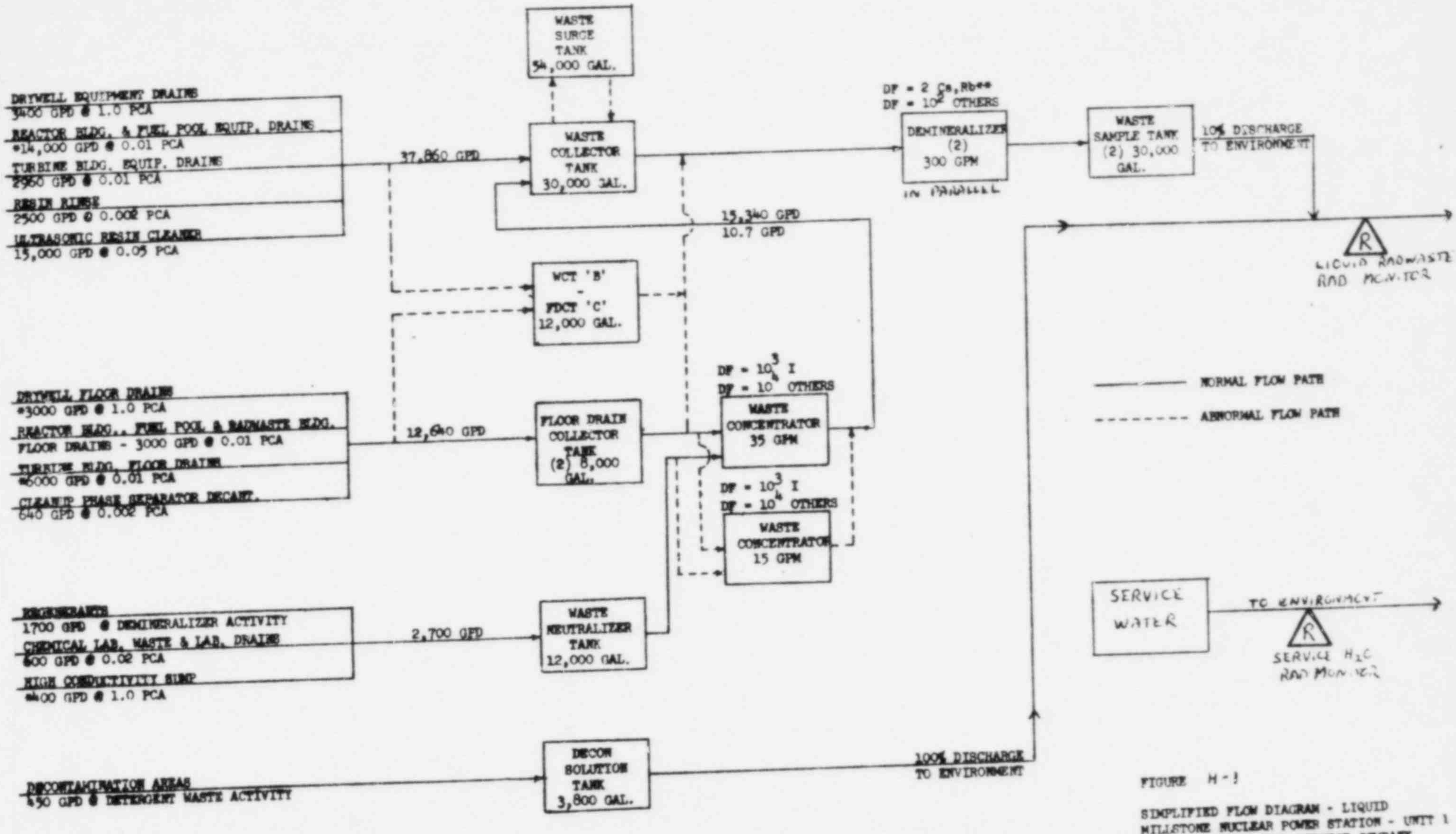


Figure G-3

AQUATIC SAMPLING STATIONS
Millstone Nuclear Power Station

H. EFFLUENT FLOW DIAGRAMS

Figures H-1, H-2, H-3 and H-4 present simplified flow diagrams for the liquid and gaseous radwaste systems for both Units 1 and 2. They also indicate the location of the radiation monitors listed in the Technical Specifications.



* - Flow rate based on operating experience.
** - DF's for an evaporator polishing demineralizer are 10 for all isotopes (Pg. C-94, Reg. Guide 1.CC)

FIGURE H-1

SIMPLIFIED FLOW DIAGRAM - LIQUID
MILLSTONE NUCLEAR POWER STATION - UNIT 1
NORTHEAST UTILITIES SERVICE COMPANY

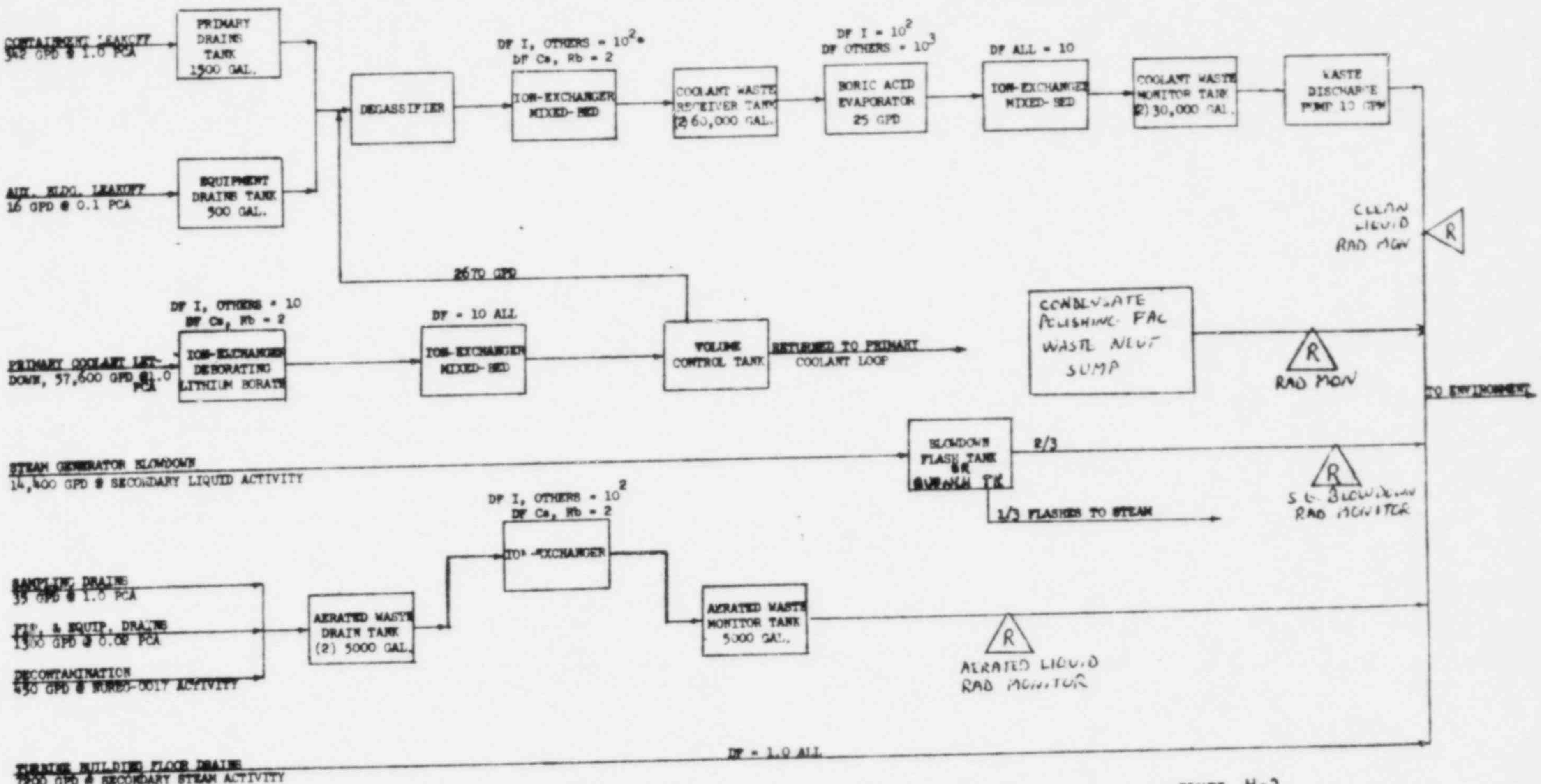
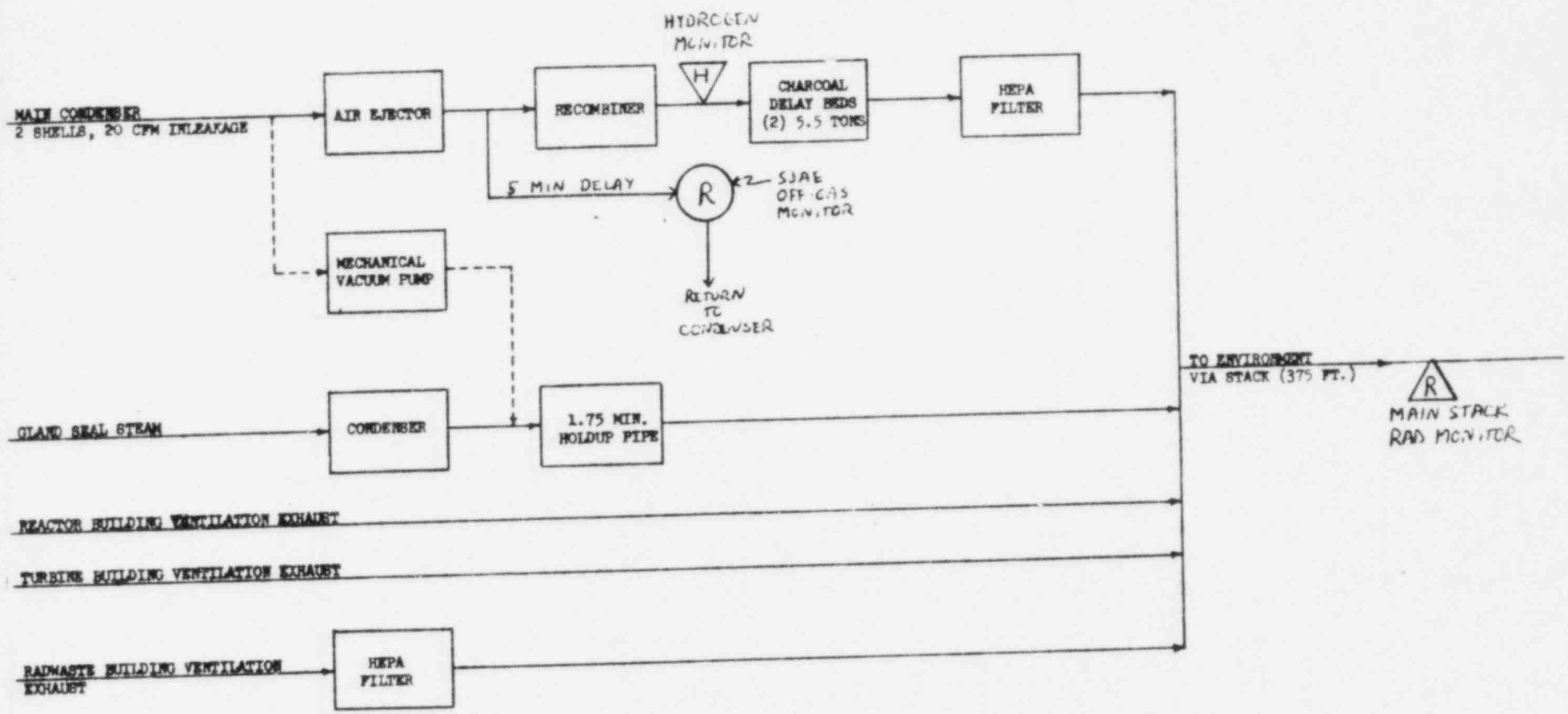


FIGURE H-2
SIMPLIFIED FLOW DIAGRAM - LIQUID
MILLSTONE NUCLEAR POWER STATION - UNIT 2
NORTHEAST UTILITIES SERVICE COMPANY

* DF FOR REACTOR COOLANT LETDOWN: DF = 10 ALL



The offgas system is based on the proposed augment which replaces a 100 minute holdup pipe with a recombiner & charcoal delay beds.

The mechanical vacuum pump is not a normal flow path (intermittent operation).

FIGURE H-3
SIMPLIFIED FLOW DIAGRAM - GASEOUS
MILLSTONE NUCLEAR POWER STATION - UNIT 1
NORTHEAST UTILITIES SERVICE COMPANY

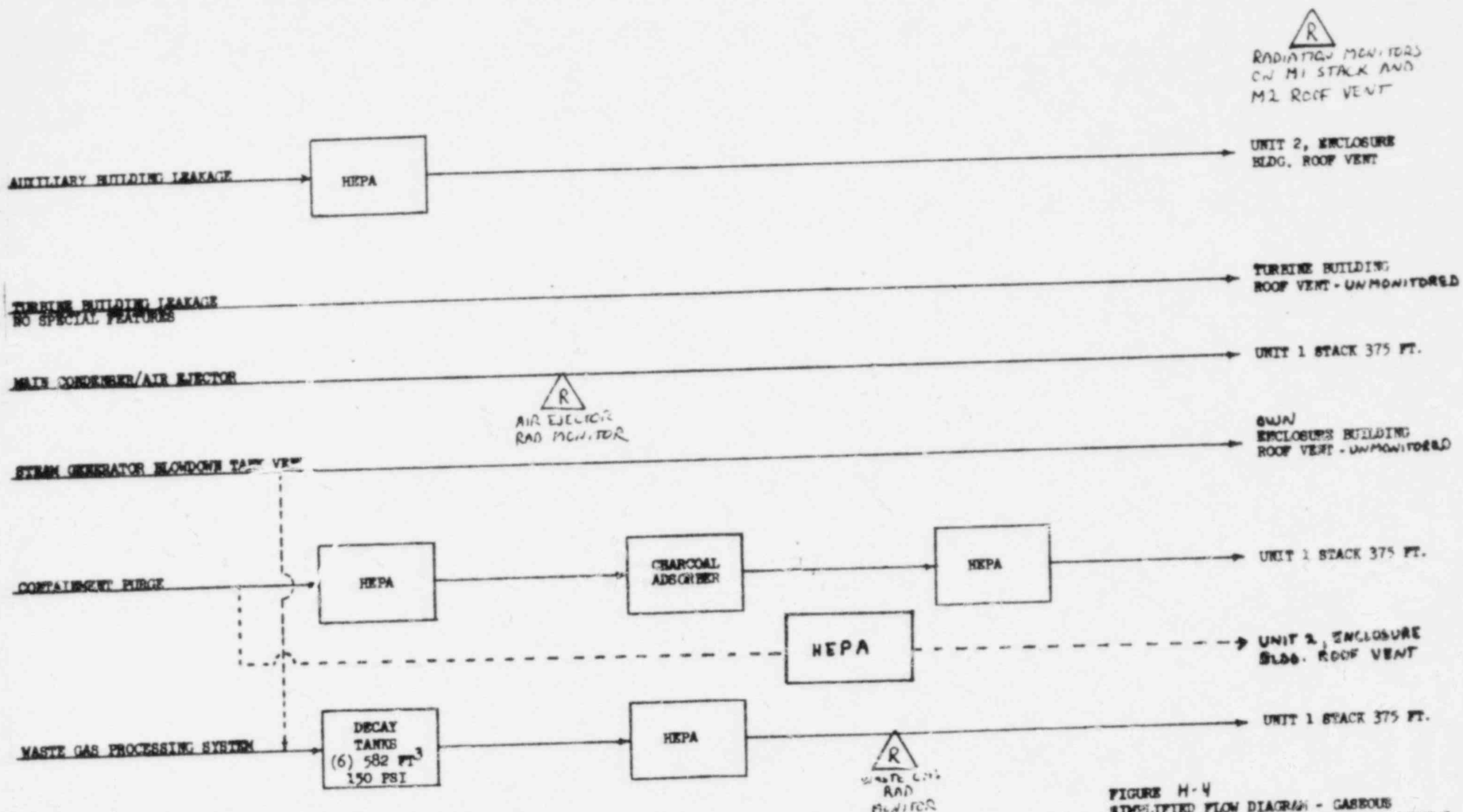


FIGURE H-4
SIMPLIFIED FLOW DIAGRAM - GASEOUS
MILLSTONE NUCLEAR POWER STATION - UNIT 2
NORTHEAST UTILITIES SERVICE COMPANY

APPENDIX A

DERIVATION OF FACTORS FOR SECTION C.1 - LIQUID DOSES

1. Section C.1.a - Step 3

Unit 1 - Liquid Doses

Year	Qtr.	C_F	$D_{QT(F)}$	$D_{QT(F)}/C_F$ (mrem/Ci)	C_H	$D_{QT(H)}$	$D_{QT(H)}/C_H$ (mrem/Ci)
1976	1	8.60	7.6(-2)	8.8(-3)	5.12	ND	-
	2	0.053	1.3(-4)	2.5(-3)	9.19	2.1(-6)	2.3(-7)
	3	0.48	6.8(-3)	1.4(-2)	1.33	ND	-
	4	0.15	1.3(-3)	8.7(-3)	4.42	1.9(-6)	4.3(-7)
1977	1	0.12	1.1(-3)	9.2(-3)	3.11	7.3(-7)	2.3(-7)
	2	0.36	4.6(-3)	1.3(-2)	0.64	1.3(-7)	2.0(-7)
	3	0.012	1.1(-4)	9.2(-3)	0.002	8.0(-10)	4.0(-7)
	4	0.028	1.5(-4)	5.4(-3)	0.66	2.3(-7)	3.5(-7)
1978	1	0.119	1.3(-3)	1.1(-2)	0.98	3.9(-7)	3.9(-7)
	2	0.049	5.2(-4)	1.1(-2)	1.29	2.9(-7)	2.2(-7)

Unit 2 - Liquid Doses

Year	Qtr.	C_F	$D_{QT(F)}$	$D_{QT(F)}/C_F$ (mrem/Ci)	C_H	$D_{QT(H)}$	$D_{QT(H)}/C_H$ (mrem/Ci)
1976	1	0.102	1.8(-4)	1.8(-3)	34.7	1.2(-5)	3.4(-7)
	2	0.179	2.4(-4)	1.3(-3)	87.3	2.7(-5)	3.1(-7)
	3	0.037	0.9(-4)	2.4(-3)	70.0	2.0(-5)	2.8(-7)
	4	0.025	1.0(-4)	4.0(-3)	85.4	3.7(-5)	4.3(-7)
1977	1	0.217	7.0(-4)	3.2(-3)	60.1	2.1(-5)	3.4(-7)
	2	0.802	6.1(-3)	7.6(-3)	73.3	3.0(-5)	4.1(-7)
	3	0.035	1.6(-4)	1.6(-4)	42.1	1.5(-5)	3.5(-7)
	4	0.509	1.9(-3)	3.7(-3)	35.0	1.1(-5)	3.3(-7)
1978	1	0.432	5.2(-3)	1.2(-2)	1.8	8.9(-7)	4.9(-7)
	2	1.27	6.6(-3)	5.2(-3)	43.6	1.2(-5)	2.7(-7)

where,

C_F = Curies of fission and activation products released during calendar quarter.

$D_{QT(F)}$ = Calculated total body dose to the maximum individual (mrem) due to fission and activation products. Dose calculated using computer code LADTAP.

C_H = Curies of tritium released during calendar quarter.

$D_{QT(H)}$ = Calculated total body dose to the maximum individual (mrem) due to tritium releases. Dose calculated using computer code LADTAP.

Maximum Value of $D_{QT(F)}/C_F$ - Unit 1 = 1.4×10^{-2} mrem/Ci

Unit 2 = 1.2×10^{-2} mrem/Ci

Average Value of $D_{QT(F)}/C_F$ - Unit 1 = 9.3×10^{-3} mrem/Ci

Unit 2 = 4.6×10^{-3} mrem/Ci

Maximum Value of $D_{QT(H)}/C_H$ - Unit 1 = 4.3×10^{-7} mrem/Ci

Unit 2 = 4.9×10^{-7} mrem/Ci

Average Value of $D_{QT(H)}/C_H$ - Unit 1 = 3.1×10^{-7} mrem/Ci

Unit 2 = 3.6×10^{-7} mrem/Ci

Since the maximum values observed of $D_{QT(F)}/C_F$ and $D_{QT(H)}/C_H$ are not much different for the two units, the same factor can be used for both units for simplicity. Also, since the maximum values are less than 3 times the average values, this says that the dose per total curie does not fluctuate greatly, hence this method is not over-conversative.

$$D_{QT(F)}/C_F = 1.4 \times 10^{-2} \text{ mrem/Ci}$$

$$D_{QT(H)}/C_H = 4.9 \times 10^{-7} \text{ mrem/Ci}$$

2. Section C.1.b - Justification for Only Using Only Particular Nuclide

Unit 1 Liquid Doses - Nuclide Breakdown
Percent of Dose

Year	Qtr.	Cs-134	Cs-137	Co-60	Mn-54	Ba-140	Co-58	Fe-59
1976	1	48	46	1	1	1	1	1
	2	29	41	14	1	2	5	2
	3	1	1	10	3	1	1	84
	4	1	1	45	7	1	1	39
1977	1	26	30	33	4	1	1	1
	2	42	47	9	1	1	1	1
	3	38	48	9	1	1	1	1
	4	24	35	18	1	1	19	1
1978	1	5	12	64	2	1	13	1
	2	2	1	77	2	1	3	11
	Avg.	22	26	28	2	1	4	14

Unit 2 Liquid Doses - Nuclide Breakdown
Percent of Dose

Year	Qtr.	Cs-134	Cs-137	Co-60	Co-58	H-3	Fe-59	Mn-54	Zn-65
1976	1	1	4	7	35	8	38	3	1
	2	1	30	5	17	11	30	1	1
	3	1	5	10	38	28	3	1	9
	4	2	7	4	31	37	16	1	1
1977	1	1	1	11	39	3	43	1	1
	2	1	1	60	25	1	10	1	1
	3	1	2	43	33	15	1	1	1
	4	13	12	30	36	1	1	3	1
1978	1	3	3	68	20	1	1	4	1
	2	5	5	56	21	1	3	5	1
	Avg.	3	7	29	30	10	14	2	1

Listed above, are all of the nuclides which have contributed more than 1% to the quarterly total body dose during the past 2-1/2 years. The only nuclides which have ever contributed more than 10% of the total body dose are:

For Unit 1: Cs-134, Cs-137, Co-58, Co-60, and Fe-59

For Unit 2: Cs-134, Cs-137, Co-58, Co-60, Fe-59, and H-3

The average percent of the total body dose accounted for by these few nuclides is:

For Unit 1: 94%

For Unit 2: 93%

The minimum percent of the total body dose accounted for by these few nuclides in any one quarter is:

For Unit 1: 86%

For Unit 2: 84%

Therefore, using only these few nuclides for Method 2, the real dose should not exceed (1.0)/0.84=1.2 mrem.

3. Section C.1.b - Step 3

Dose due to Cs-134 = $\frac{C134\ (Ci)}{V\ (gal)}$ x 10^{12} pCi/Ci x 0.26 gal/liter x 1/5 x

x [21/4 kg x 4.0 x 10^{1} pCi/kg per p Ci/liter x 1.2 x 10^{-4} mrem/pC +

5/4 kg x 2.5 x 10^{1} PCi/kg per pC/liter x 1.2 x 10^{-4} mrem/pCi

+ 100 l/m^{2} day x 67/4 hr x 0.5 x 748 day x 1.2 x 10^{-8} mrem/hr per pCi/m^{2}]

= 5.2 x 10^{10} $\frac{C134}{V}$ [2.5 x 10^{-2} + 0.37 x 10^{-2} + 0.75 x 10^{-2}]

= 1.9 x 10^{9} * C134/V

where,

1/5	=	Near field dilution factor (Table 1.3.2-1 of MP2 10CFR50, App. I)
21/4	=	Quarterly usage factor - Adult fish (Reg. Guide 1.109)
5/4	=	Quarterly usage factor - Adult shellfish (Reg. Guide 1.109)
67/4	=	Quarterly shoreline usage - teen (Reg. Guide 1.109)
4.0 x 10^{1}	=	Cs bioaccumulation factor - saltwater fish (Reg. Guide 1.109)
2.5 x 10^{1}	=	Cs bioaccumulation factor - saltwater shellfish (Reg. Guide 1.109)
1.2 x 10^{-4}	=	Cs-134 ingestion dose conversion factor - adult total body (Reg. Guide 1.109)
100	=	Proportionality factor from Reg. Guide 1.109
0.5	=	Shore width factor (Reg. Guide 1.109)
748 days	=	Half life of Cs-134
1.2 x 10^{-8}	=	External dose factor for shoreline pathway for Cs-134 - total body - (Reg. Guide 1.109)

Likewise, dose due to Cs-137

$$= 5.2 \times 10^{10} \frac{C137}{V} [21/4 \times 4.0 \times 10^{1} \times 7.1 \times 10^{-5} + 5/4 \times 2.5 \times 10^{1}$$

$$\times 7.1 \times 10^{-5} + 100 \times 67/4 \times 0.5 \times 1.1 \times 10^{4} \times 4.2 \times 10^{-9} \times (1-e - \frac{.692 \times 15}{30}$$

$$= 1.5 \times 10^{9} * C_{137}/V$$

where,

7.1×10^{-5}	=	Cs-137 ingestion dose conversion factor - adult total body (Reg. Guide 1.109)
1.1×10^{4}	=	Half life of Cs-137 in days
4.2×10^{-9}	=	External dose factor for shoreline pathway for Cs-137 - total body (Reg. Guide 1.109)
15	=	Period of time sediment is exposed to the contaminated water, in years - from Reg. Guide 1.109.
30	=	Half life of Cs-137 in years all other terms are defined above.

Likewise, dose due to Co-58

$$= 5.2 \times 10^{10} \frac{C58}{V} [21/4 \times 1.0 \times 10^{2} \times 1.67 \times 10^{-6} + 5/4 \times 1.0 \times$$

$$10^{3} \times 1.67 \times 10^{-6} + 100 \times 67/4 \times 0.5 \times 71 \times 7.0 \times 10^{-9}]$$

$= 1.8 \times 10^{8} * C_{58}/V$, where

1.0×10^{2}	=	Co bioaccumulation factor - saltwater fish (Reg. Guide 1.109)
1.0×10^{3}	=	Co bioaccumulation factor - saltwater shellfish - (Reg. Guide 1.109)
1.67×10^{-6}	=	Co-58 ingestion dose conversion factor - adult total body - (Reg. Guide 1.109)
71	=	Half life of Co-58 in days.
7.0×10^{-9}	=	External dose factor for shoreline pathway for Co-58 - total body (Reg. Guide 1.109)

All other terms are defined above.

Likewise, dose due to Co-60

$$= 5.2 \times 10^{10} \frac{C60}{V} [21/4 \times 1.0 \times 10^{2} \times 4.7 \times 10^{-6} + 5/4 \times 1.0 \times$$

$$\times 10^{3} \times 4.7 \times 10^{-6} + 100 \times 67/4 \times 0.5 \times 1.9 \times 10^{3} \times 1.7 \times 10^{-8}$$

$$\times (1 - e^{\frac{-.693 \times 15}{5.2}})]$$

$$= 1.6 \times 10^{9} * C_{60}/V$$

where,

4.7×10^{-6}	=	Co-60 ingestion dose conversion factor - adult total body (Reg. Guide 1.109)
1.9×10^{3}	=	Half life of Co-60 in days
1.7×10^{-8}	=	External dose factor for shoreline pathway for Co-60 - total body (Reg. Guide 1.109)
5.2	=	Half life of Co-60 in years.

All other terms are defined above.

Likewise, dose due to Fe-59

$$= 5.2 \times 10^{10}\ C59/V\ [21/4 \times 3.0 \times 10^{3} \times 3.9 \times 10^{-6} + 5/4 \times 2.0 \times 10^{4}$$

$$\times 3.9 \times 10^{-6} + 100 \times 67/4 \times 0.5 \times 45 \times 8.0 \times 10^{-9}]$$

$$= 8.3 \times 10^{9} * C_{59}/V$$

where

3.0×10^{3}	=	Fe bioaccumulation factor - saltwater fish (Reg. Guide 1.109)
2.0×10^{4}	=	Fe bioaccumulation factor - saltwater shellfish (Reg. Guide 1.109)
3.9×10^{-6}	=	Fe-59 ingestion dose conversion factor - adult total body (Reg. Guide 1.109)
45	=	Half life of Fe-59 in days.
8.0×10^{-9}	=	External dose factor for shoreline pathway for Fe-59 - total body (Reg. Guide 1.109)

Likewise, dose due to H-3,

$= 5.2 \times 10^{10}$ CT/V $[21/4 \times 9.0 \times 10^{-1} \times 1.05 \times 10^{-7} + 5/4 \times 9.3$
$\times 10^{-1} \times 1.05 \times 10^{-7}]$

$= 3.2 \times 10^{4}$ * CT/V

where,

9.0×10^{-1}	=	H-3 bioaccumulation factor - saltwater fish (Reg. Guide 1.109)
9.3×10^{-1}	=	H-3 bioaccumulation factor - saltwater shellfish (Reg. Guide 1.109)
1.05×10^{-7}	=	H-3 ingestion dose conversion factor - adult total body (Reg. Guide 1.109)

APPENDIX B

DERIVATION OF FACTORS FOR SECTION C2 - LIQUID DOSES

1. Section C.2.a - Step 2

Unit 1 - Liquid Doses

Year	Qtr.	C_F	Max. Organ	D_{QO}	D_{QO}/C_F
1976	1	8.60	GI (LLI)	0.054	0.0062
	2	0.053	GI (LLI)	0.0003	0.0056
	3	0.48	GI (LLI)	0.059	0.123
	4	0.15	GI (LLI)	0.0057	0.038
1977	1	0.12	GI (LLI)	0.0021	0.018
	2	0.36	GI (LLI)	0.0041	0.011
	3	0.012	GI (LLI)	0.00017	0.014
	4	0.028	GI (LLI)	0.00086	0.031
1978	1	0.119	GI (LLI)	0.024	0.202
	2	0.049	GI (LLI)	0.0031	0.063

Unit 2 - Liquid Doses

Year	Qtr.	C_F	Max. Organ	D_{QO}	D_{QO}/C_F
1976	1	0.102	GI (LLI)	0.0017	0.016
	2	0.179	GI (LLI)	0.0051	0.028
	3	0.037	GI (LLI)	0.0024	0.065
	4	0.025	GI (LLI)	0.00075	0.030
1977	1	0.217	GI (LLI)	0.012	0.055
	2	0.802	GI (LLI)	0.036	0.045
	3	0.035	GI (LLI)	0.0014	0.040
	4	0.509	GI (LLI)	0.012	0.024
1978	1	0.432	GI (LLI)	0.039	0.090
	2	1.27	GI (LLI)	0.13	0.120

where,

C_F = Curies of fission and activation products released during calendar quarter.

GI (LLI) = Gastro - Intestinal Tract - Lower Large Intestine.

D_{QO} = Calculated critical organ dose to the maximum individual (mrem) for the calendar quarter. Dose was calculated using the computer code LADTAP.

Note = Tritium has never contributed more than 1% to the maximum organ dose and thus is not included in the calculation.

Maximum Value of D_{QO}/C_F - Unit 1 - 0.202 mrem/Ci
Unit 2 - 0.120 mrem/Ci

Average Value of D_{QO}/C_F - Unit 1 - 0.055 mrem/Ci
Unit 2 - 0.050 mrem/Ci

Since the maximum value of D_{QO}/C_F is within a factor of two for both units, the same factor can be used for both units for simplicity. Also, since the maximum value is within a factor of 4 of the average value, this says that the dose per total curies does not fluctuate greatly, hence this method is not over-conservative.

Thus, D_{QO}/C_F = 0.2 mrem/Ci

APPENDIX C

LADTAP - LIQUID DOSE CALCULATIONS

The LADTAP code was written by the NRC to compute doses from liquid releases using the models given in Regulatory Guide 1.109. There is no revision date on the copy of the code which was obtained, but it was purchased in March 1976. The only change made to the code since that time was a change in the ingestion dose factors from those given in Rev. 0 of Reg. Guide 1.109 to those in Rev. 1.

For calculating the maximum individual dose at Millstone, the following options and parameters are used:

1. Real time, measured dilution flow
2. Salt water site
3. Reconcentration - cycle time - 12 hrs. (MP1 and 2 FES)

   Recycle fraction = 0.025 (MP1 and 2 FES)
4. Shorewidth factor = 0.5 (Table A-9, Regulatory Guide 1.109)
5. Dilution for Max. Individual Pathways = 5-Surface-High Velocity Discharge (Table 1.3.2-1 of MP2, 10CFR50, Appendix I)
6. 1 Hour Discharge Transit Time - time to transit quarry; estimated from chloride study
7. Reg. Guide 1.109 usage factors for Max. Individual for fish, shellfish, shoreline, swimming and boating pathways
8. Zero usage for algae, drinking water, and irrigated food pathways.

APPENDIX D

DERIVATION OF FACTORS FOR SECTION D GASEOUS DOSES

1. X/Q's, D/Q's

Unit 1 Stack
Elevated X/Q's, D/Q's

Quarterly Averages - Maximum Values

Year	Quarter	Maximum X/Q	Maximum D/Q
1976	1	2.7E-08	1.3E-09
	2	2.8E-08	2.1E-09
	3	4.7E-08	5.5E-09
	4	2.6E-08	7.9E-09
1977	1	2.3E-08	1.4E-09
	2	4.1E-08	4.2E-10
	3	4.8E-08	2.2E-09
	4	5.4E-08	4.8E-09
1978	1	4.7E-08	6.6E-09
	2	5.3E-08	1.2E-09
	3	4.0E-08	2.2E-09
	4	7.1E-08	4.3E-09

Maximum Quarterly Average X/Q = 7.1×10^{-8} Sec/M^3

Maximum Quarterly Average D/Q = 7.9×10^{-9} M^{-2}

Unit 2 - Vent

Quarterly Average X/Q's - D/Q's
Maximum Values

		Maximum X/Q		Maximum D/Q	
Year	Quarter	Continuous	Batch	Continuous	Batch
1976	1	5.0E-06	ND	4.3E-08	ND
	2	1.3E-05	ND	6.7E-08	ND
	3	4.4E-06	8.1E-06	4.5E-08	8.0E-08
	4	2.2E-06	5.9E-06	2.5E-08	6.5E-08
1977	1	2.8E-06	4.1E-06	3.2E-08	5.4E-08
	2	1.9E-06	1.4E-06	1.3E-08	1.3E-08
	3	8.2E-06	7.5E-06	1.5E-07	1.5E-07
	4	3.5E-06	2.6E-06	6.9E-08	5.2E-08
1978	1	2.5E-06	ND	4.3E-08	ND
	2	5.3E-06	1.6E-06	8.7E-08	2.9E-08
	3	9.1E-06	8.2E-06	1.4E-07	1.1E-07
	4	3.3E-06	4.2E-06	8.7E-08	8.0E-08

Maximum Quarterly Average X/Q = 1.3×10^{-5} Sec/M^3

Maximum Quarterly Average D/Q = 1.5×10^{-7} M^{-2}

From the above data we can also see that the batch releases are of a random enough nature such that the batch release meteorology approximates the continuous meteorology as shown by the average of the above values:

Average Max. Qtr. X/Q - Continuous Release - 5.1×10^{-6}

Average Max. Qtr. X/Q - Batch Releases - 4.8×10^{-6}

Average Max. Qtr. D/Q - Contiuous Releases - 6.7×10^{-8}

Average Max. Qtr. D/Q - Batch Releases - 7.0×10^{-8}

Therefore, the same X/Q's and D/Q's can be used for both batch and continuous releases.

2. Section D.1.a - Noble Gas Release Rate Limits

Unit 1 Gaseous Releases - Curies vs. Dose

Year	Quarter	Avg. Noble Gas Release Rate (μCi/Sec)	Max. Individual Dose (mrem) W.B.	Skin	mrem per μCi/Sec W.B. and Skin
1976	1	17,400	1.9	1.9	1.1 (-4)
	2	25,600	4.2	4.3	1.6 (-4)
	3	20,100	3.4	3.4	1.7 (-4)
	4	2,600	0.3	0.3	1.0 (-4)
	1-4	16,400	9.8	9.9	6.0 (-4)
1977	1	11,600	1.1	1.1	8.6 (-5)
	2	13,000	1.9	1.9	1.5 (-4)
	3	24,000	4.6	4.6	1.9 (-4)
	4	29,700	2.2	2.2	7.4 (-5)
	1-4	19,600	9.8	9.8	5.0 (-4)
1978	1	50,800	4.4	4.4	8.7 (-5)
	2	20,800	3.1	3.1	1.5 (-4)
	3	350	0.04	0.04	1.3 (-4)
	4	530	0.03	0.03	6.4 (-5)
	1-4	18,100	7.6	7.6	4.2 (-4)

Unit 2 Stack Gaseous Releases - Curies vs. Dose

Year	Quarter	Avg. Noble Gas Release Rate (μCi/Sec)	Max. Individual Dose (mrem) W. B.	Skin	mrem per μCi/Sec W.B.	Ratio Skin/W.B.
1976	1	0.63	0.00016	0.00047	2.5 (-4)	2.9
	2	83	0.058	0.16	7.0 (-4)	2.8
	3	54	0.015	0.055	2.8 (-4)	3.7
	4	63	0.022	0.035	3.5 (-4)	1.6
	1-4	50	0.095	0.25	1.9 (-3)	2.6
1977	1	134	0.023	0.058	1.7 (-4)	2.5
	2	70	0.007	0.018	1.0 (-4)	2.8
	3	39	0.019	0.056	4.9 (-4)	2.9
	4	69	0.010	0.030	1.4 (-4)	3.0
	1-4	78	0.059	0.162	7.6 (-4)	2.7
1978	1	10	0.0068	0.012	6.8 (-4)	1.8
	2	91	0.019	0.058	2.1 (-4)	3.1
	3	313	0.13	0.37	4.2 (-4)	2.8
	4	21	0.0054	0.011	2.6 (-4)	2.0
	1-4	109	0.16	0.45	1.5 (-3)	2.8

Maximum value of mrem/year per µCi/sec release rate is for 1976 for both units. These values are for whole body doses:

Unit 1: 6.0×10^{-4} mrem/yr. per µCi/sec

Unit 2: 1.9×10^{-3} mrem/yr. per µCi/sec

The 10CFR20 limit is 500 mrem to the whole body and 3000 mrem to the skin. Since the skin dose has never been as much as six times the whole body dose for Unit 1 or Unit 2 releases, we can use the 500 mrem as the limiting dose. Therefore, the release rate limits would be:

Unit 1: $500/6.0 \times 10^{-4} = 830{,}000$ µCi/sec

Unit 2: $500/1.9 \times 10^{-3} = 260{,}000$ µCi/sec

However, 10CFR20 is a site limit, therefore the limit is:

$$\frac{Q1}{830{,}000} + \frac{Q2}{260{,}000} \leq 1$$

where,

Q_1 = noble gas release rate from MP1 stack (µCi/sec)

Q_2 = noble gas release rate from MP2 vent (µCi/sec)

Justification for Above Method

The above method of determining instantaneous release rates will ensure compliance with 10CFR20 for the following reasons:

1. The doses presented for Unit 1 were calculated using the EPA AIREM code, which uses a finite cloud model similar to that in Reg. Guide 1.109. This code has compared very favorably with data actually measured at the critical site boundary with a pressurized ion chamber. Plant related quarterly doses measured by the ion chamber were calculated using a model developed by ERDA's Health and Safety Lab. These doses have always been within 30% of those calculated by AIREM. The average difference has been 14%, with the AIREM code calculating the higher dose. Thus, we are ensured that the AIREM code yields reasonable, if not slightly conservative, estimates of the maximum individual whole body dose.

2. The doses presented for Unit 2 were calculated using the NRC GASPAR code which uses the methodology of Reg. Guide 1.109.

3. The dose per curie released can be seen from the tables not to vary significantly from one quarter to the next.

Unit 1: Minimum Value - 6.4×10^{-5} mrem/qtr. per μCi/sec

Average Value - 1.2×10^{-4} mrem/qtr. per μCi/sec

Maximum Value - 1.9×10^{-4} mrem/qtr. per μCi/sec

Unit 2: Minimum Value - 1.0×10^{-4} mrem/qtr. per μCi/sec

Average Value - 3.4×10^{-4} mrem/qtr. per μCi/sec

Maximum Value - 7.0×10^{-4} mrem/qtr. per μCi/sec

It can be seen that the maximum value observed is only a factor of 2 greater than the average value even though there have been significant changes in the isotopic compositions of the releases and/or the meteorological frequencies.

The isotopic changes include significant operational changes such as:

a. Operation with and without the recombiner-charcoal delay system on the Unit 1 off-gas.

b. Periods when a unit was down the entire quarter for refueling.

c. Quarters with many MP2 containment purges and quarters with no purges.

d. Quarters with relatively high and relatively low fuel leakage from MP1.

Thus, the dose per curie released is not that sensitive to operational changes such that a gross curie release ratio can be used. We have been conservative in taking the worst annual ratio observed.

4. It should also be recognized that there is a great deal of conservatism between this method and the actual requirements of 10CFR20 for the following reasons:

   a. 10CFR20 states that release rates may be averaged over a year, however we are using this as an instantaneous release rate limit.

   b. 10CFR20 limits are ground level concentration limits, which for elevated releases from the Unit 1 stack would be less restrictive than the use of the elevated finite cloud model as used here.

5. It must also be recognized that the type of empiracal method given above is the only practical operational method. The use of a method similar to that given in NUREG-0133 would be an

operational nightmare, would be next to impossible to implement and could yield allowable release rates many times that given above.

For example, releases from the Unit 1 stack could include any of the following releases:

MP1 ventilation from radiological areas
MP1 off-gas releases from the off-gas treatment system
MP1 off-gas releases via the 30 minute holdup pipe
MP1 mechanical vacuum pump
MP1 gland seal condenser
MP2 waste gas tank discharge
MP2 containment purges
MP2 ventilation from radiological areas
MP2 condenser air ejector
MP2 mechanical vacuum pump

These sources may exist in any possible combination and each has its own particular, but changing, nuclide mixtures. Thus, the ratio of nuclides being released is a constantly changing parameter.

It is impractical to recalculate a stack release rate based on isotope specific dose conversion factors each time a source stream is initiated or terminated or a new isotopic analysis is performed on any of the source streams. This could require 4 or 5 recalculation and monitor set point changes each day. The plant could not operate in this manner.

It would also be unnecessarily restrictive to assume the worst possible mixture and use that as the limit for all situations. The only practical solution is to use a conservatively determined empirical method as given above.

3. Section D.1.b - Iodine, Particulate and Other Limits

a. Iodine

Iodine Releases vs. Dose - Unit 1

Year	Quarter	Curies I-131	Thyroid Dose mrem	mrem/Ci
1976	1	0.58	0.6	1.0
	2	0.75	3.8	5.1
	3	0.58	4.9	8.4
	4	0.29	0.6	2.1
	1-4	2.20	9.9	4.5
1977	1	0.38	0.3	0.8
	2	0.59	1.2	2.0
	3	1.57	5.4	3.4
	4	2.11	4.6	2.2
	1-4	4.65	11.5	2.5
1978	1	1.70	8.7	5.1
	2	1.15	3.1	2.7
	3	0.18	0.6	3.3
	4	0.16	0.3	1.9
	1-4	3.19	12.7	4.0

Iodine Release vs. Dose - Unit 2

Year	Quarter	Curies I-131	Thyroid Dose mrem	mrem/Ci
1976	1	3.3 (-3)	0.015	4.5
	2	4.0 (-3)	0.076	19.0
	3	1.8 (-3)	0.077	43.7
	4	4.2 (-4)	0.023	54.8
	1-4	9.5 (-3)	0.191	20.1
1977	1	2.6 (-4)	0.010	38.5
	2	1.8 (-3)	0.047	26.1
	3	6.9 (-4)	0.037	53.6
	4	2.5 (-3)	0.064	25.6
	1-4	5.2 (-3)	0.158	30.4
1978	1	6.9 (-4)	0.024	34.8
	2	1.0 (-3)	0.051	51.0
	3	5.7 (-3)	0.52	91.2
	4	6.7 (-5)	0.017	253.8
	1-4	7.5 (-3)	0.612	81.6

Maximum Value for MP1 is for 1976

= 4.5 mrem/Ci I-131

Maximum Value for MP2 is for 1978

= 81.6 mrem/Ci I-131

Limit is 1500 mrem/yr. to the thyroid

MP1 allowable release rate

$= 1500 \text{ mrem}/4.5 \text{ mrem} \times 10^{6}\ \mu\text{Ci/Ci} \times 3.17 \times 10^{-8}\ \text{yr/sec} = 10.6\ \mu\text{Ci/sec}$

MP2 allowable release rate

$= 1500 \text{ mrem}/81.6 \text{ mrem} \times 10^{6} \times 3.17 \times 10^{-8} = 0.58\ \mu\text{Ci/sec}$

Since this is a site limit, the allowable release rate for I-131 is:

$$\frac{Q_{I1}}{10.6} + \frac{Q_{I2}}{0.58} \leq 1$$

where

Q_{I1} = Release rate of I-131 from MP1 Stack (μCi/sec)

Q_{I2} = Release rate of I-131 from MP2 Stack (μCi/sec)

b. Particulates with Half Lives Greater Than 8 Days

Particulate Releases vs Dose - Unit 1

Year	Quarter	Total Curves Particulates	Max. Organ Ex. Thyroid	Max. Organ Dose	mrem/Ci
1976	1	0.040	Bone	7.9 (-3)	0.20
	2	0.043	Bone	2.1 (-2)	0.49
	3	0.051	Bone	1.7 (-2)	0.33
	4	0.014	Bone	1.1 (-2)	0.79
	1-4	0.148	-	5.7 (-2)	0.39
1977	1	0.009	Bone	3.2 (-3)	0.36
	2	0.014	Liver	4.3 (-3)	0.31
	3	0.075	Bone	1.8 (-2)	0.24
	4	0.103	Bone	5.0 (-2)	0.49
	1-4	0.201	-	7.6 (-2)	0.38
1978	1	0.156	Bone	1.6 (-1)	1.02
	2	0.963	Bone	9.5 (-2)	0.10
	3	0.131	Bone	2.7 (-2)	0.21
	4	0.105	Bone	2.8 (-2)	0.27
	1-4	1.355	-	3.1 (-1)	0.23

Particulate Releases vs Dose - Unit 2

Year	Quarter	Total Part. Curies	Max. Organ Ex. Thyroid	Max. Organ Dose	mrem/Ci
1976	1	5.5 (-4)	GI (LLI)	1.7 (-3)	3.1
	2	7.0 (-5)	Liver	6.0 (-4)	8.6
	3	1.2 (-5)	Bone	6.7 (-4)	55.8
	4	4.6 (-4)	Bone	1.2 (-2)	26.1
	1-4	1.1 (-3)	-	1.5 (-2)	13.6
1977	1	2.5 (-4)	Bone	1.8 (-3)	7.2
	2	1.0 (-4)	Liver	2.1 (-4)	2.1
	3	1.5 (-5)	Bone	2.7 (-4)	18.0
	4	4.4 (-4)	Bone	1.2 (-3)	2.7
	1-4	8.1 (-4)	-	3.5 (-3)	4.3
1978	1	8.1 (-4)	GI (LLI)	1.1 (-3)	1.4
	2	2.7 (-4)	Bone	2.2 (-3)	8.1
	3	1.0 (-4)	Bone	2.8 (-3)	28.0
	4	3.9 (-4)	Bone	6.0 (-4)	0.4
	1-4	1.6 (-3)	-	6.7 (-3)	4.2

Maximum Value for MP1 is for 1976

= 0.39 mrem/Ci

Maximum Value for MP2 is for 1976

= 13.6 mrem/Ci

Limit is 1500 mrem/yr to the maximum organ

MP1 allowable release rate

$= 1500 \text{ mrem}/0.39 \text{ mrem/Ci} \times 10^6 \text{ µCi/Ci} \times 3.17 \times 10^{-8} \text{ yr/sec} =$ 122 µCi/sec

MP2 allowable release rate

$= 1500/13.6 \times 10^6 \times 3.17 \times 10^{-8} = 3.5$ µCi/sec

Since this is a site limit, the allowable release rate for particulates is:

$$\frac{Q_1}{122} + \frac{Q_2}{3.5} \leq 1$$

where

Q_1 = Release rate of total particulates with half lives greater than 8 days from the MP1 Stack (µCi/sec)

Q_2 = Release rate of total particulates with half lives greater than 8 days from the MP2 Stack (μCi/sec)

c. Tritium

Unit 1 Tritium Releases - Curies vs. Dose

Year	Quarter	Tritium Curies	Dose (mrem) Due to Tritium	mrem/Ci
1976	1	3.71	2.5 (-5)	6.7 (-6)
	2	1.47	8.1 (-6)	5.5 (-6)
	3	11.4	8.2 (-5)	7.2 (-6)
	4	12.1	6.2 (-5)	5.1 (-6)
	1-4	28.7	1.8 (-4)	6.3 (-6)
1977	1	7.17	3.2 (-5)	4.5 (-6)
	2	9.24	7.5 (-5)	8.1 (-6)
	3	19.3	1.8 (-4)	9.4 (-6)
	4	29.5	1.9 (-4)	6.3 (-6)
	1-4	65.2	4.8 (-4)	7.4 (-6)
1978	1	16.8	1.7 (-4)	1.0 (-5)
	2	7.68	8.6 (-5)	1.1 (-5)
	3	13.1	1.1 (-4)	8.5 (-6)
	4	11.1	1.7 (-4)	1.5 (-5)
	1-4	48.7	5.4 (-4)	1.1 (-5)

Unit 2 Tritium Releases - Curies vs. Dose

Year	Quarter	Tritium Curies	Dose (mrem) Due to Tritium	mrem/Ci
1976	1	0.2	1.7 (-4)	8.5 (-4)
	2	2.2	3.0 (-3)	1.4 (-3)
	3	5.6	3.2 (-3)	5.7 (-4)
	4	3.7	1.7 (-3)	4.5 (-4)
	1-4	11.7	8.1 (-3)	6.9 (-4)
1977	1	11.2	5.1 (-3)	4.5 (-4)
	2	2.9	7.3 (-4)	2.5 (-4)
	3	7.4	1.1 (-2)	1.5 (-3)
	4	2.7	1.3 (-3)	4.8 (-4)
	1-4	24.2	1.8 (-2)	7.4 (-4)
1978	1	0.0003	-	-
	2	2.2	8.5 (-4)	3.9 (-4)
	3	23.4	4.2 (-2)	1.8 (-3)
	4	23.2	1.6 (-2)	7.0 (-4)
	1-4	48.8	5.9 (-2)	1.2 (-3)

Maximum value for MPl is for 1978

$= 1.1 \times 10^{-5}$ mrem/Curie H-3

Maximum Value for MP2 is for 1978

$= 1.2 \times 10^{-3}$ mrem/curie - H-3

Limit is 1500 mrem/yr to the maximum organ

MP1 allowable release rate

$= (1500 \text{ mrem}/1.1 \times 10^{-5} \text{ mrem/Ci}) \times 10^{6}\ \mu\text{Ci/Ci} \times 3.17 \times 10^{-8} \text{ yr/sec} = 4.3 \times 10^{6}\ \mu\text{Ci/sec}$

MP2 allowable release rate

$= (1500/1.2 \times 10^{-3}) \times 10^{6} \times 3.17 \times 10^{-8} = 4.0 \times 10^{4}\ \mu\text{Ci/sec}$

Since this is a site limit, the allowable release rate for tritium is:

$$\frac{Q_{T1}}{4.3 \times 10^{6}} + \frac{Q_{T2}}{4.0 \times 10^{4}} \leq 1$$

where

Q_{T1} = Release rate of tritium from MP1 Stack - (μCi/sec)

Q_{T2} = Release rate of tritium from MP2 Stack - (μCi/sec)

Since exposure to tritium produces whole body exposure, the release rate fraction for tritium must be added to the release rate for I-131 and particulates. The combined release rate limits then are:

I-131 and tritium

$$\frac{Q_{I1}}{10.6} + \frac{Q_{I2}}{0.58} + \frac{Q_{T1}}{4.3 \times 10^{6}} + \frac{Q_{T2}}{4.0 \times 10^{4}} \leq 1$$

Particulates and tritium

$$\frac{Q_{1}}{122} + \frac{Q_{2}}{3.5} + \frac{Q_{T1}}{4.3 \times 10^{6}} + \frac{Q_{T2}}{4.0 \times 10^{4}} \leq 1$$

4. Section D.2.a - Noble Gas - Quarterly Air Dose - Method 1

(1) Unit 1

From Table in Section D.1.a of this Appendix, the maximum quarterly value of mrem/qtr. per μCi/sec is 1.9×10^{-4}. This value is mrem to the whole body. To convert to mrad air dose we must multiply by 2 because there is a factor of 0.7 to go from mrad to whole body mrem (The Distribution of Absorbed Dose Rates in Humans From Exposure to Environmental Gamma Rays, Health Physics, January 1976) and also a factor of 0.7 for building shielding and occupancy (Regulatory Guide 1.109, Rev. 1, Pg. 43) used to originally calculate the whole body results. Therefore, the conversion factor for the air dose is:

3.8×10^{-4} mrad/qtr. per μCi/sec or

$$3.8 \times 10^{-4} \frac{\text{mrad-sec}}{\text{qtr.- Ci}} \times 10^{6} \ \mu\text{Ci/Ci} \times 1.26 \times 10^{-7} \ \text{qtr./sec}$$

$$= 4.8 \times 10^{-5} \ \text{mrad/Ci}$$

This is the gamma air dose at the critical location. Since the critical location is the site boundary and is only 0.5 miles from a 375 foot stack, the beta air dose at the critical location is near zero as the dose is from the overhead finite cloud (see earlier discussion in Section D.1.a). The beta air dose at the critical location has always been less than 0.01 times the gamma dose. Thus, the beta dose can be recorded as:

$$\leq 4.8 \times 10^{-7} \ \text{mrad/Ci}$$

(2) Unit 2

Likewise, for Unit 2 from Section D.1.a, the maximum quarterly value of mrem/qtr. per μCi/sec is 7.0×10^{-4}.

Converting to mrad/Ci we have

$$7.0 \times 10^{-4} \times 2 \times 10^{6} \times 1.26 \times 10^{-7} =$$

$$= 1.8 \times 10^{-4} \ \text{mrad/Ci}$$

This is the gamma air dose. The following is the ratio of the beta air dose to the gamma air dose at the critical location as calculated by the GASPAR code:

Ratio

	1976	1977	1978
1st. qtr.	2.9	3.1	6.9
2nd. qtr.	2.9	3.0	2.8
3rd. qtr.	3.5	2.5	3.0
4th. qtr.	3.0	3.0	3.0

The average ratio = 3.3

Beta air dose = 5.9×10^{-4} mrad/Ci

5. Section D.2.b

Unit 1 Finite Cloud Code

Year	Quarter	Curies Xe-138	Dose @ 600m NE Due to Xe-138	Dose/Curie
1976	1	2.4×10^4	0.29	1.2 (-5)
	2	3.9×10^4	0.61	1.6 (-5)
	3	3.3×10^4	0.52	1.6 (-5)
	4	7.5×10^3	0.08	1.0 (-5)
1977	1	2.1×10^4	0.19	8.9 (-6)
	2	1.9×10^4	0.22	1.2 (-5)
	3	3.4×10^4	0.52	1.5 (-5)
	4	3.4×10^4	0.22	6.4 (-6)
1978	1	6.5×10^4	0.31	4.8 (-6)
	2	4.7×10^4	0.57	1.2 (-5)
	3	9.0×10^2	0.019	2.1 (-5)
	4	1.6×10^3	0.015	9.2 (-6)

The above table normalizes the dose for each quarter to the same location from a particular radionuclide. Thus, the only variance in dose per curie should be due to the quarterly meteorology. Using this method, we can determine that the worst case meteorology occurred during the 3rd quarter 1978. Thus, the 3rd quarter joint frequencies should be used as input for the AIREM code.

6. Section D.3

a. Unit 1

The only significant contributor to the thyroid dose is I-131. If the particulates were significant a different organ would be limiting. Tritium releases have never contributed more than 1% of the doses from Unit 1.

Thus, to determine the quarterly thyroid dose we can use the maximum quarterly value observed of mrem/curie of I-131 as presented in Section 3 of this appendix.

This maximum value is:

8.4 mrem/curie - I-131

The critical organ dose due to particulates with half lives greater than 8 days can also be determined from the maximum quarterly dose per curie given in Section 3 of this appendix.

This maximum value is:

1.1 mrem/curie of particulates

b. Unit 2

For Unit 2, we must consider tritium in both the calculation of the thyroid and other organ doses. The dose factor for all organs for tritium is the same.

The maximum values of mrem per curie as presented in Section 3 of the appendix are as follows:

For I-131, 250 mrem/Ci - I-131

For Particulates 55 mrem/Ci - Particulates

For Tritium 1.8×10^{-3} mrem/Ci - H-3

APPENDIX E

GASEOUS DOSE CALCULATIONS - GASPAR

The GASPAR code was written by the NRC to compute doses from gaseous releases using the models given in Regulatory Guide 1.109. The revision date of the code which was purchased is February 20, 1976. The only changes made to the code were to change the dose factors and inhalation rates from those given in Rev. 0 of Reg. Guide 1.109 to those in Rev. 1.

For calculating the maximum individual dose at Millstone, the following options and parameters are used:

1. Real time meteorology using a X/Q, D/Q model which incorporates the methodology of Reg. Guide 1.111 - see Appx. G. Meteorology is determined separately for continuous releases and batch releases and for elevated releases and vent releases.

2. 100% of vegetation grown locally, 76% of vegetation intake from garden.

3. Animals on pasture April through December - 100% pasture intake.

4. Air water concentration equals 8 g/m^3.

5. Maximum individual dose calculations are performed at the land location with maximum decayed X/Q, at the nearest vegetable garden (assumed to be nearest residence) with the maximum D/Q, and at the cow and goat farms with maximum D/Q's.

APPENDIX F

GASEOUS DOSE CALCULATIONS - AIREM

The AIREM code was written by the EPA to compute doses from atmospheric emissions of radionuclide. The code is composed of two basic parts - a diffusion calculation and a dose calculation.

For the maximum individual dose at Millstone, cloud gamma doses are calculated using dose tables from a model which considers the finite extent of the cloud in the vertical direction. Beta doses are calculated assuming semi-infinite cloud concentrations which are based opon a standard sector averaged diffusion equation.