NORTHEAST NUCLEAR ENERGY COMPANY

MILLSTONE NUCLEAR POWER STATION

UNITS NO. 1, 2 & 3

SEMIANNUAL RADIOACTIVE EFFLUENTS REPORT

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ADDENDUM

CHANGES TO THE RADIOLOGICAL EFFLUENT MONITORING AND OFF-SITE DOSE CALCULATION MANUAL (REMODCM)

As mentioned in *Section 5* of *Volume 1*, the REMODCM was updated in its entirety. This was the first major revision since its initial issue in January 1986.

Since the entire manual has been revised and hence constitutes a large volume, it is being provided as a separate bound addendum to the Semiannual Effluent Report.

The first part of this addendum provides an evaluation of the noneditorial changes and justifies their acceptability from a radiological environmental review aspect. Attachments to these environmental reviews provide a detailed listing of all the changes. Following these reviews are the revised pages to the REMODCM.

RADIOLOGICAL ENVIRONMENTAL REVIEW

MILLSTONE STATION RADIOLOGICAL EFFLUENT MONITORING MANUAL

CHANGE REQUEST #90-1

INTRODUCTION

Attachment 1 lists the proposed changes to the Millstone Station Radiological Effluent Monitoring Manual. Several of these changes need to be reviewed in detail. The other changes are editorial. Those requiring review include:

1. Liquid waste sampling and analysis requirements

   a. Increasing the sampling frequency for analyses of dissolved and entrained gases to, prior to each batch for batch releases.

   b. Deleting the requirements for Unit 3 blowdown sampling when blowdown is being recovered.

2. Liquid radioactive waste processing requirements

   a. Changing the equipment for Unit 1 processing from waste concentrator A or B to filtration and ion exchange system.

   b. Separating the different systems for all three units and adding an additional processing stream for Unit 3.

3. Gaseous effluents sampling and analysis requirements

   Reducing the Unit 1 requirements for additional charcoal and particulate samples by allowing the factoring out of increases due to changes in thermal power level.

4. Gaseous radioactive waste processing requirements.

   Deleting requirements for operation of the auxiliary building ventilation filter and the SLCRS filter for Unit 3.

5. Changes in the radiological environmental monitoring program

   a. Reducing the frequency of the gamma analyses on air particulates.

   b. Reducing the number of bottom sediment sampling locations from 7 to 5.

   c. Reducing the number of lobster sampling locations from 3 to 2.

   d. Reducing the requirement for Sr analysis on goat milk from every sample to monthly on composites.

   e. Changing the analysis requirement for sea water samples from fractional beta to gross beta.

f. Adding separate reporting levels for shellfish in Table E-2 and footnote that allows for a factor of 3 multiplication for on-site samples.

g. Changing the requirement for missing data to be reported in the next annual report instead of as soon as possible in a supplementary report.

These items have been reviewed to determine:

1. If there is an increase in liquid or gaseous curie releases or changes in the nuclides of such releases,
2. If there is an increase in dose to the public,
3. If the sampling and monitoring capabilities are adequate.

DISCUSSION

1. Liquid waste sampling and analysis requirements

   a. Increasing the sampling frequency for analyses of dissolved and entrained gases to prior to each batch for batch releases is more conservative. This sampling frequency is necessary to verify compliance with the individual unit instantaneous release rate limits for dissolved and entrained gases.

   b. Deleting the requirement for Unit 3 blowdown sampling when blowdown is being recovered is acceptable since this sampling is only necessary for releases to the environment. There are no releases from this pathway when blowdown is being recovered.

2. Liquid radioactive waste processing requirements

   a. Although a radiological environmental review has already been performed for this change (see PDCR 1-95-86), since the new system has been in operation, actual DF's (decontamination factors - amount of reduction of radioactivity of the liquid from processing) were reviewed. Floor drain collection tank data for several tanks in September 1988 indicate DF's in the 10-50 range for Mn-54, Co-60 and Cs-137. However, these were for tanks with relatively low activities. DF's should increase with higher activities. Therefore, the DF's as listed in the original radiological environmental review may be realistic. In any case, the increase in dose calculated for the original review shows doses higher than those in our Appendix I submittal. Therefore, this change should be considered an unreviewed radiological environmental impact. (NOTE: This is in contrast to the original review.) However, the doses are low and should be within the Appendix I Design Guidelines. (If not, our Technical Specifications require a 30-day letter to the NRC.) Confirmation of this is shown in 1986-1987 doses where the total maximum organ doses are 0.012 and 0.031 mrem, respectively, to the maximum individuals. Assuming worst case conditions, where the organ dose for the maximum individual may reach 10 mrem, the population dose would be approximately 30 person rem (based upon 1986-1987 Unit 1 data). This converts to a potential cost of $30,000. The reduction of radwaste realized by this treatment system more than offsets this cost. The above facts indicate that this change is acceptable.

   b. The separation of the different liquid waste streams for all three units was done for clarification. No requirements were changed, except for 2a, above and the addition of one waste stream for Unit 3. This addition is more restrictive; therefore, the above changes are acceptable.

3. Gaseous effluents sampling and analysis requirements.

   The isotopic mix is not expected to change if the increase in reactor coolant I-131 activity is consistent with power increase. Therefore, the change allowing the factoring out of increases due to changes in thermal power level is acceptable.

4. Gaseous radioactive waste processing requirements.

   The Unit 3 auxiliary building filters should not have originally been required as part of any routine operating system. The FSAR does not list it as such; per the FSAR wording, subsequent to an alarm on the ventilation vent, exhaust air is manually diverted through one of the two filter units. This system can handle only 30,000 CFM. This is well below the total of approximately 200,000 CFM for the auxiliary building ventilation. Since this system was not designed to operate in a routine fashion, long-term use would be an operational nightmare. After 720 hours of operations, the filter banks require testing. Any operation (grinding, welding, or painting) that may "contaminate" the charcoal beds must be prohibited in areas that vent to this system. Therefore, it can be concluded that this system is acceptable to delete as a requirement for routine operation.

   The Unit 3 SLCRS filter also, should not have originally been required as part of any routine system. The FSAR states that the SLCRS is not normally in operation. This system starts on receipt of a Safety Injection System signal. It takes suction on the containment enclosure building and its adjoining building and discharges the air to its main filter banks. Therefore, it can be concluded that this system is acceptable to delete as a requirement for routine operation.

5. Changes in the radiological environmental monitoring program

   a. Quarterly composites of the weekly air particulate samples satisfy the requirements specified in Table. 3.12-1 of NUREG-0472 (Rev. 3). Note that as specified in NUREG-0472, if individual samples show gross beta results that are ten times greater than the control results, then a gamma isotopic shall be performed on the individual samples.

   b. NUREG-0472 (Rev. 3) recommends that one sample of bottom sediment be taken from the downstream area with existing or potential recreational value. Five locations (two control, three indicator) more than adequately satisfy this recommendation.

   c. Although NUREG-0472 (Rev. 3) recommends a control sample for each species of fish and invertebrates, historical data has shown that this is not necessary. Rarely are any non-plant related man-made isotopes seen in the aquatic media. The only instances where this has occurred were the major fallout events, such as Chinese weapons fallout. In any case, other control samples (e.g., oysters) will provide adequate data. Therefore, deleting the control lobster sample is acceptable.

   d. Strontium analyses are not required by NUREG-0472 (Rev. 3). However, the milk pathway has been a sensitive issue in the past. Therefore, we have decided to keep the strontium analysis requirements. Monthly Sr analyses are adequate since the Sr-89 and Sr-90 half-lives are much greater than 30 days.

e. Although NUREG-0472 does not have a requirement for any beta analyses on sea water samples, this analysis is utilized as a "screening level" for reduction in the LLD. The change from fractional to gross beta will not have an adverse impact on this check.

f. Table E-2 lists the reporting levels for the more important plant related radionuclides. Because of the lower consumption rate for shellfish, values for fish are conservative. Therefore, a column was added for shellfish. These values were calculated using the same dose criteria as for the other pathways. Note that due to the lower consumption rate, these values are approximately 4 times the values for fish. Also, these values apply to actual samples consumed by the public. For on-site samples, these values may be multiplied by the near field dilution factor. The factor for this site is 3.

g. Although NUREG-0472 recommends that any missing data not available for the annual report be submitted as soon as possible in a supplemental report, the timeliness of the data reporting is not crucial. Such occurrences of late data are unusual and it would be much easier to have it included in an appendix to the next report. This would make the tracking and storage of the data much easier.

Conclusion

These changes will maintain the level of radioactive effluent control required by 10 CFR 20.106, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

Based upon the above discussion, it can be concluded that the above changes are an Unreviewed Radiological Environmental Impact, but are acceptable.

Performed By: John W. Daurelio 5/17/90

Reviewed By: Lemuel Lord 5/18/90

Reviewed By: R.A. Crandall 5-18-90

Reviewed By: Jeffrey J. Slaton 6-5-90

MILLSTONE STATION RADIOLOGICAL EFFLUENT MONITORING MANUAL

Changes and Rationale for Revision 2

Pg. B-1 - Superintendent → Director - To reflect current title.

Pg. C-1 - analysis → analyses - Editorial

Pg. C-2 - Editorial changes for clarification. Increased the sampling frequency for dissolved and entrained gases from one batch per month to prior to each batch for batch releases.

Pg. C-3 - minutes → minute - Editorial
radio - nuclide → radionuclide - Editorial
Added "an" before a posteriori - Editorial.
Added "In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample" to end of item a.

Pg. C-4 - rsults → results - typo
release → released - Editorial
Prioir → Prior - typo
sample → samples - Editorial
waste → wastes - Editorial

Pg C-5 - Increased the sampling frequency for dissolved and entrained gases from one batch per month to prior to each batch for batch releases. Editorial changes for clarification. Reactor Building Closed Cooling Service Water Outlet → Service Water Effluent - clarification. Added footnote k. to service water.

Pg. C-6 - Added "an" before a posteriori - Editorial.

Pg. C-7 - Added words "of the Safety Technical Specifications" after Table 4.7-2 for Notations e. and h. for clarification. Release → released in notation g. Deleted "for the service water" from notation i so that it now applies to all continuous pathways. Analyses → analysis in notation j.

Pg. C-8 - Increased the sampling frequency for dissolved and entrained gases from one batch per month to prior to each batch for batch releases. Editorial changes for clarification.
Task → Tank - typo. Added Boron Test Tanks to batch release sampling requirements since they are also batch release tanks. Added footnote k. to Service Water Effluent.

Pg. C-9 - Added "an" before a posteriori - Editorial.

Pg. C-10 - Table 4.7-2 → Table 4.7-1 - typo. Added the words "of the Safety Technical Specifications" after Table 4.7-1 for Notations e. and h. for clarification. Releases → released in notation g. Deleted "for the service water" from footnote i so that it now applies to all continuous pathways. Analyses → analysis in notation j. Added wording to footnote h to delete the requirements for blowdown sampling when blowdown is being recovered.

Pg. C-11 - systems → system - Editorial
Waste concentrator A or B → Filtration and ion exchange system - reflect change as approved in PDCR 87-1.
Separated the different systems for all three units for clarification.
Added an additional waste stream for Unit 3.
Added wording to clarify the requirements for equipment operability.

Pg. D-2 - Editorial changes for clarification.

Pg. D-3 - Revised wording for notation a. Added "Sampling and" to beginning of notation c. for clarification.
Analyses → analysis - Editorial
Added wording to the second sentence in notation f. to allow for factoring out increases due to changes in thermal power level.

Pg. D-4 - Editorial changes for clarification.

Pg. D-5 - Notation → Notations, Item a, in Notation a.
Added "Sampling and" to beginning of notation c. for clarification.
Analyses → analysis - Editorial

Pg. D-7 - Editorial changes for clarification.
Expanded wording in batch release category to include drawdown of containment as a batch release. Also added footnote h.

Pg. D-8 - Notation → Notations, Item a, in Notation a. Added "Sampling and" to beginning of notation c. for clarification.
Analyses → analysis - Editorial.
Expanded wording on footnote f. for clarification.
Added "from the ventilation vent" to footnote g. Added footnote h to allow for more expedient recovery from medical emergencies.

Pg. D-9 - systems → system - Editorial
Deleted the auxiliary building ventilation and SLCRS filters as necessary equipment for Unit 3 gaseous radioactive waste treatment.
reasons → reason - Editorial
Added wording to clarify the requirement for equipment operability.

Pg. E-1 - Moved paragraph "If milk..." to a better location within the text.

Pg. E-2 - Added "to" after word "equal" - Editorial.
Added "an" before a posteriori - Editorial.

Pg. E-3 - Deleted word "both" since it referred to more than 2 items - Editorial

Pg. E-5 - Monthly → Quarterly composites for gamma spectrum analysis - less frequent criteria for this pathway complies with the acceptable minimum program specified on Table 3.12-1 of NUREG-0472 (Draft Standard RETS).
7 → 5 locations for bottom sediment - fewer locations satisfies criteria in Table 3.12-1 of NUREG-0472.
3 → 2 locations for lobsters - control location is not necessary.
lobster → lobsters - Editorial
Sr requirements from every sample → on monthly composites - again satisfies NUREG-0472. Sr has long halflife, therefore, composites are acceptable.

Fractional beta → gross beta. NUREG-0472 does not require any beta analysis on seawater, however, it is utilized to screen samples to determine if more sensitive gamma analyses are necessary. The above charge has no effect on this screening determination.

Pg. E-5 and E-6	-	Editorial changes for clarification.
Pg. E-7	-	Changed order of isotopes and format of the numbers - Editorial. Added reporting levels for Ag-110m and I-131 in fish. Also added a column for shellfish with a footnote to allow for near field dilution.
Pg. E-8	-	Be-140 → Ba-140 - typo.
Pg. E-9	-	particulate → particular - typo. Added "an" before <u>a posteriori</u> - Editorial fractional → gross
Pg. F-1	-	"as soon as possible in a supplementary report" to "in the next annual report" - to minimize unnecessary paperwork and allow easier tracking of data. Reports → Report - Editorial
Pg. F-2	-	Likely most → most likely - Editorial
Pg. F-3	-	Added wording to reflect the changes that were made in the Technical Specifications per Change Requests 1-2-89, 2-3-89, and 3-13-89.

RADIOLOGICAL ENVIRONMENTAL REVIEW

MILLSTONE OFFSITE DOSE CALCULATION MANUAL CHANGE REQUEST #90-1

Introduction

After three years of using the Offsite Dose Calculation Manual (ODCM), it is a prudent time to review its adequacy. This review has determined that there are significant areas for improvement. Several dose calculation methods have the potential for underestimating the doses. Three more years of plant operation have supplied more data to serve as a basis. Review of NUREG -0133, Preparation of Radiological Effluent Technical specifications for Nuclear Power Plants, indicates that the use of its methods are appropriate. Therefore, the ODCM has been revised to reflect the necessary changes for improvement. Attachment 1 lists the details to these changes.

Discussion

The following details the reasons for the major changes.

1. Sections C.1 and C.2

   Whole body and maximum organ dose calculations were revised to include a separate equation for Unit 1. This became necessary since the recent operating experience of the zinc injection system had changed the isotopic mixture of the Unit 1 liquid discharges. This change in isotopic mixture has caused Unit 1's dose factors to significantly increase. Separate equations prevent over-conservatism for Units 2 and 3.

2. Section C.5

   The wording on the footnote at the bottom of page C-3 was expanded to prevent the possibility of underestimating projected doses. Previously, If LADTAP was used as base month, doses would be underestimated in cases when the estimated dilution flow was less than the base month's dilution flow.

3. Section D.1.a.

   Release rate limits were raised. Although these values went up by 30-40%, the dose rate limits remain unchanged. The new values are based upon 1984-1987 data and the use of less conservative assumptions. This revision to the ODCM more closely follows the recommendations of the NRC that are described n NUREG-0133. Old values were based upon the worst case year, while the new ones are based upon annual averages. This is still conservative since the 1984-1987 data are based upon worst case quarters; annual averages would be somewhat less, since the maximum doses do not always occur at the same location. Also, each unit is normally limited to $\frac{1}{3}$ of these limits to assure that the sum of the fractions is less than one.

4. Section D.1.b.

   The methods in this section were completely revised. The new methods closely follow the recommended methods of NUREG-0133. These methods are more exact in that they allow the flexibility of neglecting pathways for periods when they do not exist and require changing dispersion parameters when more critical locations appear. This flexibility better assures that doses are not underestimated.

5. Section D.2.a.

Deleted main condenser evacuation system and turbine gland sealing system from Step 3. These systems do not contribute to any measurable releases. The dose factor value in Steps 4 and 5 was increased based upon the new data listed in Appendix D. This is in the conservative direction. The other dose factors remain approximately the same.

6. Section D.2.b.

The joint frequency data was changed from the 3rd quarter 1979 to the 3rd quarter 1980 to reflect the worst case quarter based upon a more thorough examination of the data. The X/Q was decreased based upon the 1980-1987 data. The limit for switching to Method 2 was decreased; therefore, this decrease in X/Q should not cause any dose limits to be exceeded, as real time X/Q's must be used at that point.

7. Section D.3.

The methods in this section were completely revised, following similar logic as in Section D.1.b. The new methods closely follow the recommended methods of NUREG-0133. These methods are more exact; they allow the flexibility of neglecting pathways for periods which they do not exist and require changing dispersion parameters when more critical locations appear. This flexibility better assures that doses are not underestimated.

8. Section D.4.

The dose factors increased by 20-25% due to the use of new data listed in Appendix D. This is in the conservative direction.
Improved the methods for dose projections. New methods better satisfy the requirements of the Radiological Effluent Monitoring Manual (REMM).

9. Section D.6

Part C of this section was expanded to include the assumptions and method necessary to perform the direct dose calculation.

10. Sections E.1 and E.3

Restrictions were added to ensure that the 2×10^{-4} µCi/ml Dissolved Noble Gas Technical Specification limit is met. Step 5 was revised to allow for setpoint determinations with low activity concentrations. This would allow releases of small amounts of activity without termination due to small fluctuations in monitor response. This limit for low activity releases ensures that under worst case conditions, the discharge rate limits will still be maintained.

11. Section E.5

Several assumptions in this section were revised. The maximum possible steam generator blowdown flow rate was increased to 600 gpm to ensure conservatism. The remaining changes were the use of more realistic assumptions, service water was added to the dilution water flow, the limit was changed from unidentified MPC to 50% of the I-131 MPC, and background of the monitor can be added to the calculation.

12. Section E.6

This section was revised to clarify the intended functions of this monitor. It serves as a backup to the blowdown monitor and also provides rapid indication of an increased leakage rate from primary to secondary system. Therefore, the setpoint was revised to twice the monitor background at its location as long as the primary to secondary leakage rate is less than $\frac{1}{2}$ the Technical Specification limits and the blowdown activity is less than $\frac{1}{2}$ MPC's (as done in Section E,5, above).

13. Section E.7

This section was completely revised. The new setpoint ensures that the purpose of detecting high activity in between the weekly composite RBCCW samples is met.

14. Section E.8

Changes similar to E.1 and E.3

15. Section E.11

Changes similar to Section E.5.

16. Section E.12

The limit for the maximum organ dose was changed from 0.1% of 1500 mrem to 1% of the 40CFR190 limit of 75 mrem. This resulted in a factor of two descrease in dose to the maximum organ and therefore a factor of two decrease in the setpoint.

17. Section F.2

Revised to ensure that the setpoint for this monitor meets the requirements of both Section 3.2.D.1 and Section 3.8.D.6 of the Technical Specifications. For periods when the off gas treatment system is out of service, the setpoint needs to follow the more stringent criteria of Section 3.8.B.1 (per the requirement of 3.2.D.1).

18. Sections F.3, F.5, F.6, F.7 and F.8

Release rate limits raised per changes in Section D.1.a. Added wording in Sections F.5 and F.7 to ensure that if the MP-2 and/or MP-3 vent setpoints are raised, that the requirements of MP-1 Technical Specification 3.8.B.1 are still met (see F.2). Changed MP3 ventilation rate from 280,680 CFM to 210,000 CFM based upon actual conservative operating conditions.

19. Section G - Figures 1-6

These effluent flow diagram figures were deleted for several reasons. They are not referenced in the text, they only served as an initial review tool for the NRC, and there are other much better references for them (e.g., FSAR's, as the FSAR is more likely to be maintained up-do-date.

20. Appendices A-D

These appendices were updated to include more data on dose factors and meteorology. Methods improved to assure that dose calculations are either conservative or realistic when necessary. Liquid dose calculations are based upon more recent data. This became necessary because of the change in isotopic mixture at Unit 1 caused by the operation of the zinc injection system. Gaseous dose calculations more closely follow the methods of NUREG-0133.

21. Appendix G

Minor changes to correct mistakes and allow for necessary replacement of out of business farms. Bottom sediment sampling requirements were deleted at 3 locations and lobster sampling at Giant's Neck per the change in requirements of Rev. 2 of the REMM

22. Appendix H

This appendix was deleted since the requirements for sampling this pathway were deleted.

Conclusion

These changes will maintain the level of radioactive effluent control required by 10 CFR 20.106, 40 CFR Part 190, 10 CFR 50.36a, and Appendix I to 10 CFR Part 50 and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.

The above changes implement methods which result in better assurance that the limits of the Safety Technical Specifications are maintained. Although the instantaneous release rate limits have been raised, the dose limits remain unchanged. Therefore, there is no increase in potential dose to the public. The instantaneous limits are based upon conservative methods. The actual dose to the public is expected to be somewhat less.

These changes do not permit increased doses to the public, do not degrade monitoring capabilities, and are in most cases conservative. Therefore, these changes do not constitute an Unreviewed Radiological Environmental Impact.

Prepared by John W. Doroski 5/18/90

Reviewed by Leonard Londyn 5/18/90

Reviewed by R.A. Crandall 5-18-90

Millstone Station Offsite Dose Calculation Manual

Revision 2 - Changes and Rationale

Section	Change and Rationale
A	Added the word, manual, in the second paragraph. Changed "two or three methods" to "several methods." Added sentence "NUSCO Radiological Assessment Branch may perform these more detailed calculations." Methodology → method(s)
B	Superintendent → Director, to reflect current title of position.
C.1.a	Changed total → whole and changed D_{QT} → D_{QW} to eliminate any possible confusion between total and tritium. Revised the dose calculation for whole body by adding a separate calculation for Unit 1. This became necessary since one of the factors for Unit 1 has significantly increased. Rounded off 1.9 → 2 for Units 2 and 3. See Appendix D for details. Added note to allow for neglecting the dose contribution from tritium for Unit 1 since it has never accounted for more than 2% of the whole body doses.
C.1.b	Changed LADTAP → LADTAP II to allow use of Rev. 1 to Regulatory Guide 1.109. Revised the dose calculation for maximum organ dose by adding a separate calculation for Unit 1. Similar to C.1.a above, this change became necessary since the factor for Unit 1 increased significantly.
C.2.b	LADTAP→ LADTAP II
C.3	Added Σ sign. Original version had a typo. Changed total to whole and T to W to eliminate any potential for confusion with thyroid.
C.5	Expanded wording on the footnote to account for changes in dilution flow if LADTAP II is used. This will prevent doses from being underestimated. Changed total to whole and T to W as discussed above.
C.6	LADTAP → LADTAP II to allow for use of Rev. 1 to Regulatory Guide 1.109.
D.1.a.	790,000 → 1,100,000 217,000 → 290,000 217,000 → 290,000 Release rate limits are raised based upon data from 1984-1987. These values increased since NUREG-0133 allows the use of annual average dispersion conditions. Old values were based upon worst case year. See Appendix D in ODCM for details.
D.1.b.	Added * to MP3 vent releases since it is possible to vent the steam generator blowdown to the atmosphere. Methods (1), (2), and (3) revised completely into 3 methods which follow the methods of NUREG-0133 (see Appendix D). Note that the original methods did not account for any new more critical milk locations.

D.2.a

Deleted "main condenser evacuation system, and turbine gland sealing system (for the latter two systems, see Appendix H for methods to determine the number of curies)" in Step 3 since these systems do not contribute to any measurable releases.

7.6 → 9.3
D_{QB1} = 7.6 . . . DQ_{B1} < 9.3 . . .
1.8 → 1.7
1.8 → 1.7

More conservative values shown above are from the 1983-1987 data in Appendix D. This better guarantees that the limits will be met. The decrease in beta doses for Units 2 and 3 result from a small change in the beta to gamma ratio.

D.2.b

3rd quarter 1979 → 3rd quarter 1980. Based upon a better analysis of the data as shown in Appendix D, the 3rd quarter 1980 is the most critical for the period of 1976-1987. Reduced dose level for initiating need to use real time meteorological data better assures limits are not exceeded.

$0.13 \times 10^{-4} \rightarrow 0.81 \times 10^{-5}$. Lower X/Q based upon 1980-1987 data. Original value based on 2nd quarter 1976 which should have been 1.0×10^{-5}. However, more recent data indicates that the lower X/Q is more appropriate. Use of the lower X/Q is acceptable since this method is only used until one-half any limit based upon this value is reached (1.0×10^{-5} is less than 2 times $.81 \times 10^{-5}$). Real time meteorology is required if limits are reached.

D.3.a

Changed from 2 methods to 5 methods.This allows for conservatism when necessary and flexibility for less conservative calculations if certain criteria are met. Old methods were not necessarily conservative. New methods allow for any necessary changes in milk locations. They also more closely follow the methods of NUREG-0133.

D.3.b

Same changes as in D.3.a. Also deleted two systems as discussed in D.2.a above.

D.3.c

Added thyroid dose calculation. Method is the same as for maximum organ.

D.4.a.(1)

Deleted original steps 1-6 since they are not necessary.
7.6 → 9.3
6.5 → 8.0 See explanation D.2.a
0.065 → 0.08

D.4.a.(2)

Revised original method to reflect that the treatment is a HEPA filter, which reduces doses resulting from particulates.
Added additional method to allow for flexibility.

D.4.b

7.6 → 9.3
D → C in Step 3 to correct original typo.
Separated steam generator blowdown tank vent and ventilation releases to allow for differences in wording necessary for the blowdown vent calculations. Added this wording to require use of secondary coolant iodine activity instead of primary coolant iodine activity.

D.4.c Added separate method for Unit 3 steam generator blowdown tank vent since the original method is incorrect. Added wording to reference the reactor plant gaseous vents instead of the waste gas storage tanks.

D.6.c Expanded the wording to include the assumptions and method necessary to perform the direct dose calculations.

E.1 Added restrictions for noble gases to insure the 2×10^{-4} uCi/ml limit in the Technical Specifications is met.

In Step 5, added lower limit for setpoint determination to allow for releases of small amounts of activity without termination due to a small fluctuations in monitor response.

E.2 Added "Reactor Building" to title.

E.3 Same changes as in E.1.
Deleted need for Alert setpoint for clean or aerated monitors since these monitors do not have this capability.

E.4 Changed wording to indicate that the Condensate Polishing Facility Waste Neutralization sump monitor can also read out in cpm. Added the requirement that a default setpoint should be used if no grab samples are required. This default should be lower of two times background or the value as specified in E.3.

E.5 Raised flow for blowdown from 500 to 600 gpm to insure method is conservative. Added service water flow to be more realistic. MPC changed from unidentified to I-131 ($1 \times 10^{-7} \rightarrow 3 \times 10^{-7}$) since I-131 is still conservative. Release rate limit is set at 50% of this.

Added assumption d, addition of background, to setpoint calculation and defined background as the indication provided by system monitor with no activity present in the monitored system.

E.6 Added sentence at end of first paragraph.

Replaced last paragraph with better wording to allow for changing plant conditions. New wording better assures intention of setpoint.

E.7 Revised completely to insure that the purpose of detecting high activity in between the weekly composite RBCCW samples is met.

E.8 Changes similar to E.1 and E.3.

E.10 Added wording to emphasize that monitor operation is required even if grab samples may not be required.

E.11 Increased maximum blowdown flow from 304 to 400 gpm. Changed from unidentified MPC of 1×10^{-7} uCi/ml to I-131 MPC of 3×10^{-7} uCi/ml. Use of I-131 is still conservative. Reduced minimum dilution flow to account for potential of only 2 circulating water pumps. Added background to setpoint calculation.

E.12	Revised the wording in assumption b to describe the bases for the dilution flow. The dose limit in assumption f was changed to 1% of the 40CFR190 limit, which is more conservative than the previous limit.
F.1	3.8.D.6 → 3.8.D.5 to reflect correct section of Technical Specifications.
F.2	Revised to insure that this monitor meets the requirements of both Section 3.2.D.1 and Section 3.8.D.6 of the Technical Specifications.
F.3	790,000 → 1,100,000 217,000 → 290,000 217,000 → 290,000 Release rate limits raised per changes in Section D.1.a. Therefore 266,000 → 363,000. Also maximum flow rate is increased to 180,000.
F.5	Release rate limits changed as in F.3. Therefore 71,000 → 95,000. Added wording to insure that if the MP1 stack monitor setpoint needs to be decreased, an evaluation is made on the MP1 steam jet air ejector setpoint.
F.6	Similar changes as in F.3.
F.7	Release rate limits changed as in F.3 and F.5 and flow rate decreased to 210,000 CFM. Therefore 71,000 → 95,000 and 5.3×10^{-4} → 9.5×10^{-4}. Added wording to insure that if the MP1 stack monitor setpoint requires a value less than 1/3 of the site limit, then an evaluation is performed on the adequacy of the MP1 steam jet air ejector setpoint.
F.8	Release rate limits changed as in F.3, F.5, and F.7. Therefore 0.21% → 0.16%. Negative exponent in flow rate deleted; it was a typo.
G	Deleted.
Figure 1 thru Figure 6	Deleted. These exist in the FSAR's; it is a better reference for them.
Appendices A-F	Updated to include more data on dose factors and meteorology. Methods improved to assure that dose calculations are either conservative or realistic, when necessary. Liquid dose calculations are based upon more recent data because of the change in isotopic mixture at Unit 1. This change is resulting from the operation of the zinc injection system. Gaseous dose calculations more closely follow the methods of NUREG-0133.
Appendix G	Corrected distances and directions for several locations. Some original ones were incorrect and 2 milk locations went out of business. Location No. 7 was changed from Fox Island to Millstone Environmental Lab Dock and Location No. 15 was changed from Montville to Norwich to reflect actual locations. Bottom sediment sampling requirements were deleted at 3 locations and lobster sampling at Giant's Neck (per Rev. 2 of REMM).

Figure G-1	Redone for clarity.
Figure G-2	Redone for clarity and addition of milk locations.
Figure G-3	Redone for clarity.
Appendix H	Deleted since requirements for sampling this pathway were deleted.

Docket Nos.	50-245 50-336 50-423
License Nos.	DPR-21 DPR-65 NPF-44

RADIOLOGICAL EFFLUENT

MONITORING AND

OFFSITE DOSE

CALCULATION MANUAL AND

PROCESS CONTROL PROGRAM

MILLSTONE UNIT NOS. 1, 2, & 3

Northeast Nuclear
Energy Company

July 1990
Revision 2

SECTION I

RADIOLOGICAL EFFLUENT

MONITORING MANUAL

FOR THE
MILLSTONE NUCLEAR POWER STATION
UNIT NOS. 1, 2, & 3

DOCKET NO. 50-245
50-336
50-423

July 1990
Revision 2

RADIOLOGICAL EFFLUENT MONITORING MANUAL

TABLE OF CONTENTS

A. INTRODUCTION

The purpose of this manual is to provide the sampling and analysis programs which provide input to the ODCM for calculating liquid and gaseous effluent concentrations and offsite doses. Guidelines are provided for operating radioactive waste treatment systems in order that offsite doses are kept As-Low-As-Reasonably-Achievable (ALARA).

The *Radiological Environmental Monitoring Program* outlined within this manual provides confirmation that the measurable concentrations of radioactive material released as a result of operations at the Millstone Site are not higher than expected.

In addition, this manual outlines the information required to be submitted to the NRC in both the *Annual Radiological Environmental Operating Report* and the *Semiannual Radioactive Effluent Release Report*.

B. RESPONSIBILITIES

All changes to this manual shall be reviewed and approved by the Station 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 Director to ensure that this manual is used in performance of the surveillance requirements and administrative controls of the *Technical Specifications*.

C. LIQUID EFFLUENTS

C.1 Liquid Effluent Sampling and Analysis Program

Radioactive liquid wastes shall be sampled and analyzed in accordance with the program specified in *Table C-1* for Millstone Unit No. 1, *Table C-2* for Millstone Unit No. 2, and *Table C-3* for Millstone Unit No. 3. The results of the radioactive analyses shall be input to the methodology of the ODCM to assure that the concentrations at the point of release are maintained within the limits of the *Technical Specification 3.8.C.1* for Millstone Unit No. 1 and within the limits of *Technical Specification 3.11.1* for Millstone Unit Nos. 2 and 3.

Table C-1

MILLSTONE 1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (μCi/ml)
A. Batch Release[f]				
1. Waste Sample Tanks 2. Floor Drain Sample Tank 3. Decontamination Solution Tank	Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters[b]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
			Dissolved and Entrained Gases	1×10^{-5}
	Prior to Each Batch	Monthly Composite	H-3	1×10^{-5}
			Gross alpha	1×10^{-7}
	Prior to Each Batch	Quarterly Composite	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}
B. Continuous Release Reactor Building Service Water	Daily Grab Sample[d]	Weekly Composite[c]	Principal Gamma Emitters[b]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
	Monthly Grab Sample	Monthly	Dissolved and Entrained Gases	1×10^{-5}
	Weekly Grab Sample	Monthly Composite[c]	H-3[e]	1×10^{-5}
			Gross alpha[e]	1×10^{-7}
	Weekly Grab Sample	Quarterly Composite[c]	Sr-89[e], Sr-90[e]	5×10^{-8}
			Fe-55[e]	1×10^{-6}

TABLE C-1 (Cont'd.)

TABLE NOTATIONS

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):

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22\ x\ 10^6 \cdot Y \cdot exp\ (-\lambda\ \Delta\ t)}$$

where:

LLD is the lower limit of detection as defined above (as pCi 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)

E is the counting efficiency (as counts per transformation)

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

2.22×10^6 is the number of transformations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLD's unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

b. The LLD will be 5×10^{-7} µCi/ml. The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, and Cs-137.

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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report*.

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.

   Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.

d. Daily grab samples for service water taken at least five days per week.

e. These analyses are required only if weekly gamma analysis indicates a gamma activity greater than 5×10^{-7} µCi/ml.

f. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided.

Table C-2

MILLSTONE 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)[a] (μCi/ml)
A. Batch Release[b]				
1. Coolant Waste Monitor Tank 2. Aerated Waste Sample Tank 3. Condensate Polishing Facility - Waste Neutralization Sump[e]	Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters[c]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
			Dissolved and Entrained Gases[d]	1×10^{-5}
	Prior to Each Batch	Monthly Composite[f,g]	H-3[d]	1×10^{-5}
			Gross alpha[d]	1×10^{-7}
	Prior to Each Batch	Quarterly Composite[f,g]	Sr-89[d], Sr-90[d]	5×10^{-8}
			Fe-55[d]	1×10^{-6}
B. Continuous Release				
1. Steam Generator Blowdown[h] 2. Service Water Effluent 3. Turbine Building Sumps[h]	Daily Grab Sample[i]	Weekly Composite[g]	Principal Gamma Emitters[c]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
	Monthly Grab Sample	Monthly	Dissolved and Entrained Gases[j]	1×10^{-5}
	Weekly Grab Sample	Monthly Composite[g]	H-3[j]	1×10^{-5}
			Gross alpha[j]	1×10^{-7}
	Weekly Grab Sample	Quarterly Composite[g]	Sr-89[j], Sr-90[j],	5×10^{-8}
			Fe-55[j]	1×10^{-6}

Table C-2 (Cont'd.)

TABLE NOTATIONS

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):

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22\ x\ 10^6 \cdot Y \cdot exp\ (-\lambda\ \Delta\ t)}$$

where:

LLD is the lower limit of detection as defined above (as pCi 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)

E is the counting efficiency (as counts per transformation)

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

2.22×10^6 is the number of transformations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLD's unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

b. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided.

c. The LLD will be 5×10^{-7} µCi/ml. The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, and Cs-137.

Table C-2 (Cont'd.)

TABLE NOTATIONS

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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report.*

d. For the Condensate Polishing Facility (CPF) - Waste Neutralization Sump, these analyses are only required if the gamma analysis of the CPF - Waste Neutralization Sump indicates a gamma activity greater than 5×10^{-7} µCi/ml.

e. For the Condensate Polishing Facility - Waste Neutralization Sump, these analyses are only required when the steam generator gross activity (sampled and analyzed 3 times per week as per *Table 4.7-2* of the *Safety Technical Specifications*) exceeds 1×10^{-5} µCi/ml.

f. 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.

g. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.

h. For the Steam Generator Blowdown and the Turbine Building Sump, these analyses are only required when the steam generator gross activity (sampled and analyzed 3 times per week as per *Table 4.7-2* of the *Safety Technical Specifications*) exceeds 5×10^{-7} µCi/ml.

i. Daily grab samples shall be taken at least 5 days per week.

j. For the Service Water, these analyses are only required if a weekly gamma analysis indicates a gamma activity greater than 5×10^{-7} µCi/ml.

Table C-3

MILLSTONE 3

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (μCi/ml)
A. Batch Release[b] 1. Condensate Polishing Facility - Waste Neutralization Sump[e] 2. Waste Test Tanks 3. Condensate Polishing Facility - Regenerate Distillate Tank 4. Low Level Waste Drain Tank 5. Boron Test Tanks	Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters[c]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
			Dissolved and Entrained Gases[d]	1×10^{-5}
	Prior to Each Batch	Monthly Composite[f,g]	H-3[d]	1×10^{-5}
			Gross alpha[d]	1×10^{-7}
	Prior to Each Batch	Quarterly Composite[f,g]	Sr-89[d], Sr-90[d]	5×10^{-8}
			Fe-55[d]	1×10^{-6}
B. Continuous Release 1. Steam Generator Blowdown[h] 2. Service Water Effluent 3. Turbine Building Sumps[h]	Daily Grab Sample[i]	Weekly Composite[g]	Principal Gamma Emitters[c]	5×10^{-7}
			I-131, Mo-99	1×10^{-6}
			Ce-141, Ce-144	5×10^{-6}
	Monthly Grab Sample	Monthly	Dissolved and Entrained Gases[j]	1×10^{-5}
	Weekly Grab Sample	Monthly Composite[g]	H-3[j]	1×10^{-5}
			Gross alpha[j]	1×10^{-7}
	Weekly Grab Sample	Quarterly Composite[g]	Sr-89[j], Sr-90[j],	5×10^{-8}
			Fe-55[j]	1×10^{-6}

Table C-3 (Cont'd.)

TABLE NOTATIONS

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):

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22 \times 10^6 \cdot Y \cdot \exp(-\lambda\ \Delta t)}$$

where:

LLD is the lower limit of detection as defined above (as pCi 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)

E is the counting efficiency (as counts per transformation)

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

2.22×10^6 is the number of transformations per minute per microcurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between midpoint of sample collection and midpoint of counting time

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLD's unachievable. In such cases, the contributing factors will be identified and recorded on the analysis sheet for the particular sample.

b. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling, each batch shall be isolated and at least two tank/sump volumes shall be recirculated or equivalent mixing provided.

c. The LLD will be 5×10^{-7} µCi/ml. The principal gamma emitters for which this LLD applies are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Cs-134, and Cs-137.

Table C-3 (Cont'd.)

TABLE NOTATIONS

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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report*.

d. For the Condensate Polishing Facility (CPF) - Waste Neutralization Sump, these analyses are only required if the gamma analysis of the CPF - Waste Neutralization Sump indicates a gamma activity greater than 5×10^{-7} µCi/ml.

e. For the Condensate Polishing Facility - Waste Neutralization Sump, these analyses are only required when the steam generator gross activity (sampled and analyzed 3 times per week as per *Table 4.7-1* of the *Safety Technical Specifications*) exceeds 1×10^{-5} µCi/ml.

f. 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.

g. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents released.

h. For the Steam Generator Blowdown and the Turbine Building Sump, these analyses are only required when the steam generator gross activity (sampled and analyzed 3 times per week as per *Table 4.7-1* of the *Safety Technical Specifications*) exceeds 5×10^{-7} µCi/ml. Steam Generator Blowdown samples are not required when blowdown is being recovered.

i. Daily grab samples shall be taken at least 5 days per week.

j. For the Service Water, these analyses are only required if a weekly gamma analysis indicates a gamma activity greater than 5×10^{-7} µCi/ml

C.2 Liquid Radioactive Waste Treatment

All applicable liquid radioactive waste treatment systems will be operated when the projected dose due to liquid effluents averaged over 31 days exceeds 0.06 mrem to the total body or 0.2 mrem to any organ.

The term "all applicable liquid radioactive waste treatment" is defined as that equipment applicable to a waste stream responsible for greater than ten percent (10%) of the total projected dose. The liquid radioactive waste treatment system equipment is specified below for each unit.

Millstone Unit No. 1

1. Filtration and ion exchange system.

2. Waste demineralizer A or B.

Millstone Unit No. 2

1. Degasifier, clean liquid primary demineralizer, boric acid evaporator, clean liquid secondary demineralizer and filter.

2. The aerated waste demineralizer and filter.

Millstone Unit No. 3

1. Degasifier, ion exchanger, boron evaporator, boron demineralizer, and boron demineralizer filter.

2. High level waste demineralizer or waste evaporator, waste demineralizer and waste demineralizer filter.

3. Regenerant evaporator, regenerant demineralizer, and regenerant demineralizer filter.

If actual 31-day doses exceed 0.06 mrem to the total body or 0.2 mrem to any organ and the doses from the untreated pathway exceed 10% of these limits, prepare and submit to the Commission a report that includes the following information:

1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,

2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and

3. Summary description of action(s) taken to prevent a recurrence.

If the above treatment systems are not routinely operating, doses due to liquid effluents from the untreated pathway to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM. If any of these dose projections exceed 10 percent (10%) of the above limits, then best efforts shall be made to return the inoperable equipment to service.

D. GASEOUS EFFLUENTS

D.1 Gaseous Effluents Sampling and Analysis Program

Radioactive gaseous wastes shall be sampled and analyzed in accordance with the program specified in *Table D-1* for Millstone Unit No. 1, *Table D-2* for Millstone Unit No. 2, and *Table D-3* for Millstone Unit No. 3. The results of the radioactive analyses shall be input to the methodology of the ODCM to assure that the offsite dose rates are maintained within the limits of the *Technical Specifications 3.8.D.1* for Unit No. 1 and within the *Specifications of 3.11.2.1* for Unit Nos. 2 and 3.

TABLE D-1

MILLSTONE 1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (μCi/cc)
A. Steam Jet Air Ejector Discharge	Monthly - Gaseous Grab Sample[c]	Monthly[c]	Principal Gaseous Gamma Emitters[b]	1×10^{-4}
B. Main Stack	Monthly - Gaseous Grab Sample	Monthly	Principal Gaseous Gamma Emitters[b]	1×10^{-4}
			H-3	1×10^{-6}
	Continuous[d]	Weekly Charcoal Sample[f]	I-131	1×10^{-12}
			I-133[e]	1×10^{-10}
	Continuous[d]	Weekly[f] Particulate Sample	Principal Particulate Gamma Emitters - Half Lives Greater Than 8 Days[b]	1×10^{-11}
	Continuous[d]	Monthly Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[d]	Quarterly Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous[d]	Noble Gas Monitor	Noble Gases - Gross Activity	1×10^{-6}

TABLE D-1 (Cont'd.)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is defined in *Table Notations, Item a,* of *Tables C-1, C-2, or C-3.*

b. For gaseous samples, the LLD will be 1 x 10^{-4} µCi/cc and for particulate samples, the LLD will be 1 x 10^{-11} µCi/cc. The principal gamma emitters for which these LLD's apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 for gaseous emission 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. The 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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report.*

c. Sampling and analysis shall also be performed within 24 hours following an increase, as indicated by the steam jet air ejector off-gas monitor, of greater than 50%, after factoring out increases due to changes in THERMAL POWER level.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known.

e. Analyses for I-133 will not be performed on each charcoal sample. Instead, at least once per month, the ratio of I-133 to I-131 will be determined from a charcoal sample changed after 24 hours of sampling. This ratio, along with the routine I-131 activity determination will be used to determine the release rate of I-133.

f. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing. Special sampling and analysis of iodine and particulate filters shall also be performed whenever subsequent reactor coolant I-131 samples show an increase of greater than a factor of 5 after factoring out increases due to changes in thermal power level. These filters shall be changed following such a five-fold increase in coolant activity and every 24 hours thereafter until the reactor coolant I-131 levels are less than a factor of 5 greater than the original coolant levels or until seven days have passed, whichever is shorter. Sample analyses shall be completed within 48 hours of changing. The LLD's may be increased by a factor of 10 for these samples.

TABLE D-2

MILLSTONE 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)[a] (μCi/cc)
A. Batch Release				
1. Waste Gas Storage Tank[h] 2. Containment Purge	Prior to Each Tank Discharge	Each Tank Discharge	Principal Gamma Emitters[b]	1×10^{-4}
			H-3	1×10^{-6}
B. Continuous Release				
Vent	Monthly - Gaseous Grab Sample[c]	Monthly[c]	Principal Gamma Emitters[b]	1×10^{-4}
			H-3[g]	1×10^{-6}
	Continuous[d]	Weekly[f] Charcoal Sample	I-131	1×10^{-12}
			I-133[e]	1×10^{-10}
	Continuous[d]	Weekly[f] Particulate Sample	Principal Gamma Emitters[b] (I-131, others with Half lives > 8 days)	1×10^{-11}
	Continuous[d]	Monthly Composite Particulate Samples	Gross Alpha	1×10^{-11}
	Continuous[d]	Quarterly Composite Particulate Samples	Sr-89, Sr-90	1×10^{-11}
	Continuous[d]	Noble Gas Monitor	Noble Gases - Gross Activity	1×10^{-6}

TABLE D-2 (Cont'd.)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is defined in *Table Notations, Item a,* of *Tables C-1, C-2, or C-3*.

b. For gaseous samples, the LLD will be 1 x 10^{-4} µCi/cc and for particulate samples, the LLD will be 1 x 10^{-11} µCi/cc. The principal gamma emitters for which these LLD's apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 for gaseous emission 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. The 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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report*.

c. Sampling and analysis shall also be performed within 24 hours following an unexplained increase, as indicated by the Unit 2 stack noble gas monitor, of greater than 50%, after factoring out increases due to changes in THERMAL POWER levels, containment purges, or other explainable increases.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known.

e. Analyses for I-133 will not be performed on each charcoal sample. Instead, at least once per month, the ratio of I-133 to I-131 will be determined from a charcoal sample changed after 24 hours of sampling. This ratio, along with the routine I-131 activity determination will be used to determine the release rate of I-133.

f. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing. Special sampling and analysis of iodine and particulate filters shall also be performed whenever reactor coolant I-131 samples, which are taken 2-6 hours following a THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in one hour, show an increase of greater than a factor of 5. These filters shall be changed following such a five-fold increase in coolant activity and every 24 hours thereafter until the reactor coolant I-131 levels are less than a factor of 5 greater than the original coolant levels or until seven days have passed, whichever is shorter. Sample analyses shall be completed within 48 hours of changing. The LLD's may be increased by a factor of 10 for these samples.

g. Grab samples for tritium shall be taken weekly whenever the refueling cavity is flooded and there is fuel in the cavity. The grab sample shall be taken from the stack (Unit 1 and 2) where the containment ventilation is being discharged at the time of sampling.

h. Waste Gas Storage Tanks are normally released on a batch basis. However, for the purpose of tank maintenance, inspection, or reduction of oxygen concentration, a waste gas tank may be continuously purged with nitrogen provided the following conditions are met:

   (1) The previous batch of radioactive waste gas has been discharged to a final tank pressure of less than 5 PSIG.

TABLE D-2 (Cont'd.)

TABLE NOTATIONS

(2) No radioactive waste gases have been added to the tank since the previous discharge.

(3) Valve lineups are verified to ensure that no radioactive waste gases will be added to the tank.

(4) After pressurizing the tank with nitrogen, a sample of the gas in the tank will be taken and analyzed for any residual gamma emitters and tritium prior to initiation of the nitrogen purge. The measured activity will be used to calculate the amount of activity released during the purge.

TABLE D-3

MILLSTONE 3

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (µCi/cc)
A. Batch Release				
Containment Purge or Drawdown	Prior to Each Purge or Drawdown[h]	Each Purge or Drawdown	Principal Gamma Emitters[b]	1×10^{-4}
			H-3	1×10^{-6}
B. Continuous Release				
1. Unit 3 Ventilation Vent	Monthly[c] Gaseous Grab Sample	Monthly[c]	Principal Gamma Emitters[b]	1×10^{-4}
			H-3[g]	1×10^{-6}
2. Engineered Safeguards Building	Continuous[d]	Weekly Charcoal Sample[f]	I-131	1×10^{-12}
			I-133[e]	1×10^{-10}
	Continuous[d]	Weekly Particulate Sample[f]	Principal Gamma Emitters[b] (I-131, others with Half lives >8 days)	1×10^{-11}
	Continuous[d]	Monthly Composite Particulate Samples	Gross Alpha	1×10^{-11}
	Continuous[d]	Quarterly Composite Particulate Samples	Sr-89, Sr-90	1×10^{-11}
	Continuous[d]	Noble Gas Monitor	Noble Gases - Gross Activity	1×10^{-6}

TABLE D-3 (Cont'd.)

TABLE NOTATIONS

a. The lower limit of detection (LLD) is defined in *Table Notations, Item a,* of *Tables C-1, C-2, or C-3.*

b. For gaseous samples, the LLD will be 1 x 10^{-4} µCi/cc and for particulate samples, the LLD will be 1 x 10^{-11} µCi/cc. The principal gamma emitters for which these LLD's apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 for gaseous emission 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. The 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. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in a priori LLD's higher than required, the reasons shall be documented in the *Semiannual Radioactive Effluent Release Report.*

c. Sampling and analysis shall also be performed within 24 hours following an unexplained increase, as indicated by the Unit 3 vent noble gas monitor, of greater than 50%, after factoring out increases due to changes in THERMAL POWER levels, containment purges, or other explainable increases.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known.

e. Analyses for I-133 will not be performed on each charcoal sample. Instead, at least once per month, the ratio of I-133 to I-131 will be determined from a charcoal sample changed after 24 hours of sampling. This ratio, along with the routine I-131 activity determination will be used to determine the release rate of I-133.

f. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after changing. Special sampling and analysis of iodine and particulate filters shall also be performed whenever reactor coolant I-131 samples (which are taken 2-6 hours following a THERMAL POWER change exceeding 15 percent of RATED THERMAL POWER in one hour per *Table 4.4-4* of the *Safety Technical Specifications*) show an increase of greater than a factor of 5. These filters shall be changed following such a five-fold increase in coolant activity and every 24 hours thereafter until the reactor coolant I-131 levels are less than a factor of 5 greater than the original coolant levels or until seven days have passed, whichever is shorter. Sample analyses shall be completed within 48 hours of changing. The LLD's may be increased by a factor of 10 for these samples.

g. Grab samples for tritium shall be taken weekly from the ventilation vent whenever the refueling cavity is flooded and there is fuel in the cavity.

h. Subsequent to medical emergencies, for initial determination of isotopic content of the containment air, a Health Physics sample may be used in place of the normal chemistry sample.

D.2 Gaseous Radioactive Waste Treatment

All applicable gaseous radioactive waste treatment systems shall be operated when the projected dose due to gaseous effluents averaged over 31 days exceeds 0.2 mrad for gamma radiation, 0.4 mrad for beta radiation or 0.3 mrem to any organ due to gaseous particulate effluents.

The term "all applicable gaseous radioactive treatment" is defined as that equipment applicable to a waste stream responsible for greater than ten percent (10%) of the total projected dose. The gaseous radioactive waste treatment system equipment is specified below for each Unit.

Millstone Unit No. 1

Offgas System - Recombiner Train A or B
Charcoal Bed Train A or B
and the HEPA filter

Radwaste Ventilation Exhaust Treatment System Radwaste ventilation HEPA filters.

Millstone Unit No. 2

Gaseous Radwaste Treatment System - at least two (2) gas decay tanks, the waste gas filter and one waste gas compressor.

Ventilation Exhaust Treatment System - Auxiliary building ventilation HEPA filter (L26), containment purge HEPA filter (L25).

Millstone Unit No. 3

Gaseous Radwaste Treatment System - charcoal bed adsorbers, one HEPA filter, and one process gas compressor.

Building Ventilation - Fuel building ventilation filter.

If actual doses exceed 0.2 mrad for gamma radiation, 0.4 mrad for beta radiation or 0.3 mrem to any organ and the doses from the untreated pathway exceed 10% of these limits, prepare and submit to the Commission a report that includes the following information:

1. Explanation of why gaseous radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems, and the reason for the inoperability,
2. Action(s) taken to restore the inoperable equipment to OPERABLE status, and
3. Summary description of action(s) taken to prevent a recurrence.

If the above treatment systems are not routinely operating, doses due to gaseous effluents from the untreated pathway to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM. If any of these dose projections exceed 10 percent (10%) of the above limits, then best efforts shall be made to return the inoperable equipment to service.

E. RADIOLOGICAL ENVIRONMENTAL MONITORING

E.1 Sampling and Analysis

The radiological sampling and analyses provide measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from plant operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Program changes may be made based on operational experience.

The sampling and analyses shall be conducted as specified in *Table E-1* for the locations shown in *Appendix G* of the ODCM. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment or other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every effort shall be made to complete corrective action prior to the end of the next sampling period.

All deviations from the sampling schedule shall be documented in the *Annual Radiological Environmental Operating Report* pursuant to *Section F.1*. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. In these instances, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next *Semiannual Radioactive Effluent Release Report* and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

If milk samples are unavailable from any one or more of the milk sample locations required by *Table E-1*, a grass sample shall be substituted until a suitable milk location is evaluated as a replacement or until milk is available from the original location. Such an occurrence will be documented in the *Annual Radiological Environmental Operating Report*.

If the level of radioactivity in an environmental sampling medium at one or more of the locations specified in *Table E-1* exceeds the report levels of *Table E-2* when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected calendar quarter, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the limits of *Table E-2* to be exceeded. When more than one of the radionuclides in *Table E-2* are detected in the sampling medium, this report shall be submitted if:

$$\frac{concentration\,(1)}{reporting\ level\,(1)} + \frac{concentration\,(2)}{reporting\ level\,(2)} + \cdots \geq 1.0$$

When radionuclides other than those in *Table E-2* are detected and are the result of plant effluents, this Special Report shall be submitted if the potential annual dose to an individual is equal to or greater than the appropriate calendar year limit of the *Technical Specifications* 3.8.C.2.1, 3.8.D.2.1 or 3.8.D.3.1 for Millstone Unit No. 1 or *3.11.1.2, 3.11.2.2 or 3.11.2.3* for Millstone Unit Nos. 2 and 3. This report is not required if the measured level of radioactivity was not the result of plant effluents, however, in such an event, the condition shall be reported and described in the *Annual Radiological Environmental Operating Report*.

The detection capabilities required by *Table E-3* are state-of-the-art for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. All analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLD's unachievable. In such cases, the contributing factors will be identified and described in the *Annual Radiological Environmental Operating Report*.

E.2 Land Use Census

The land use census ensures that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this census. This census satisfies the requirements of *Section IV.B.3* of *Appendix I* to *10 CFR Part 50*. The land use census shall be maintained and shall identify the location of the milk animals in each of the 16 meteorological sectors within a distance of five miles.*

The validity of the land use census shall be verified at least once per 12 months by either a door-to-door survey, aerial survey, consulting local agriculture authorities, or any combination of these methods.*

With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the doses currently being calculated in the ODCM, make the appropriate changes in the sample locations of *Table E-2*.

With a land use census identifying a location(s) which has a higher D/Q than a current indicator location the following shall apply:

(1) If the D/Q is at least 20% greater than the previously highest D/Q, replace one of the present sample locations with the new one within 30 days if milk is available.

(2) If the D/Q is not 20% greater than the previously highest D/Q, consider direction, distance, availability of milk, and D/Q in deciding whether to replace one of the existing sample locations. If applicable, replacement should be within 30 days. If no replacement is made, sufficient justification should be given in the annual report.

Sample location changes shall be noted in the *Annual Radiological Environmental Operating Report.*

*Broad leaf vegetation (a composite of at least 3 different kinds of vegetation) is sampled at the site boundary in each of 2 different direction sectors with the highest D/Q in lieu of a garden census.

E.3 Interlaboratory Comparison Program

The Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission. A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the *Annual Radiological Environmental Operating Report.*

With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the *Annual Radiological Environmental Operating Report.*

TABLE E-1

MILLSTONE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1.a. Gamma Dose - Environmental TLD	17	Monthly	Gamma Dose - Monthly
1.b. Gamma Dose - Accident TLD	22	Quarterly[(a)]	N/A[(a)]
2. Airborne Particulate	8	Continuous sampler - weekly filter change	Gross Beta - Weekly Gamma Spectrum - Quarterly on composite (by location), and on individual sample if gross beta is greater than 10 times the mean of the weekly control station's gross beta results.
3. Airborne Iodine	8	Continuous sampler - weekly canister change	I-131 - Weekly
4. Vegetation	5	One sample near middle and one near end of growing season	Gamma Isotopic on each sample
5. Milk	6	Monthly for all animals except semi-monthly for goats when on pasture	Gamma Isotopic and I-131 on each sample Sr-89 and Sr-90 on monthly composite
6. Sea Water	2	Quarterly - Composite of 6 weekly grab samples	Quarterly - Gross Beta, Gamma Isotopic, and Tritium on each composite
7. Bottom Sediment	5	Semiannual	Gamma Isotopic on each sample

TABLE E-1 (Cont'd)

MILLSTONE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
8. Fin Fish - Flounder and one other type of edible fin fish	2	Quarterly	Gamma Isotopic on each sample
9. Mussels	2	Quarterly	Gamma Isotopic on each sample
10. Oysters	4	Quarterly	Gamma Isotopic on each sample
11. Clams	2	Quarterly	Gamma Isotopic on each sample
12. Lobsters	2	Quarterly	Gamma Isotopic on each sample

(a) Accident monitoring TLD's to be dedosed at least quarterly.

TABLE E-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/g, wet)	Shellfish(c) (pCi/g, wet)	Milk (pCi/l)	Vegetables (pCi/g, wet)
H-3	20,000					
Mn-54	1,000		30	140		
Fe-59	400		10	60		
Co-58	1,000		30	130		
Co-60	300		10	50		
Zn-65	300		20	80		
Zr-95	400					
Nb-95	400					
Ag-110m			8	30		
I-131	(b)	0.9	0.2	1	3	0.1
Cs-134	30	10	1	5	60	1
Cs-137	50	20	2	8	70	2
Ba-140	200				300	
La-140	200				300	

(a) For drinking water samples. This is 40 CFR Part 141 value.

(b) Level for I-131 not included since no radioactivity discharged to any drinking water pathways; other reporting levels are included for trending of long-lived isotopes only.

(c) For on-site samples, these values can be multiplied by 3 to account for the near field dilution factor.

TABLE E-3

MAXIMUM VALUES FOR LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fish, Shellfish (pCi/kg,wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross beta		1×10^{-2}				
Fractional beta	4					
H-3	2000					
Mn-54	30[c]		130			
Fe-59	60[c]		260			
Co-58,60	30[c]		130			
Zn-65	60[c]		260			
Zr-95	60[c]					
Nb-95	30[c]					
I-131	d	7×10^{-2}		1	60[b]	
Cs-134	30[c]	5×10^{-2}	130	15	60	150
Cs-137	40[c]	6×10^{-2}	150	18	80	180
Ba-140	120[c,e]			70		
La-140	30[c,e]			25		

TABLE E-3 (Cont'd)

TABLE NOTATIONS

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 lower limit of detection as defined above (as pCi 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)

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)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between midpoint of sample collection (or end of the sample collection period) and time of counting

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLD's will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLD's unachievable. In such cases, the contributing factors will be identified and described in the *Annual Radiological Environmental Operating Report.*

b. LLD for leafy vegetables.

c. To be reduced by a factor of two if the gross beta for the sample exceeds 15 pCi/l.

d. Level for I-131 not included since no radioactivity discharged to any drinking water pathway.

e. From end of sample period.

F. REPORT CONTENT

F.1 Annual Radiological Environmental Operating Report

The *Annual Radiological Environmental Operating Report* shall include summaries, interpretations, and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The report shall also include the results of the land use census required by *Section E.2* of this manual. If harmful effects are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The report shall include a summary table of all radiological environmental samples which shall include the following information for each pathway sampled and each type of analysis:

(1) Total number of analyses performed at indicator locations.

(2) Total number of analyses performed at control locations.

(3) Lower limit of detection (LLD).

(4) Mean and range of all indicator locations together.

(5) Mean and range of all control locations together.

(6) Name, distance and direction from discharge, mean and range for the location with the highest annual mean (indicator or control).

(7) Number of nonroutine reported measurements as defined in these specifications.

In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted in the next annual report.

The report shall also include a map of sampling locations keyed to a table giving distances and directions from the discharge; the report shall also include a summary of the Interlaboratory Comparison Data required by *Section E.3* of this manual.

F.2 Semiannual Radioactive Effluent Release Report

The *Semiannual Radioactive Effluent Release Report* shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit as outlined in *Regulatory Guide 1.21, Revision 1*, June 1974, with data summarized on a quarterly basis following the format of *Appendix B* thereof.

In addition, a report to be submitted 90 days after January 1 of each year, shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, and atmospheric stability, or in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability.** This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the site during the previous calendar year. The meteorological conditions concurrent with the time of release of radioactive material in gaseous effluents shall be used for determining the gaseous pathway doses. Dose calculations shall be performed in accordance with the *Offsite Dose Calculation Manual*.

In addition, the report to be submitted 90 days after January 1 of each year shall include an assessment of radiation doses to the most likely exposed REAL MEMBER OF THE PUBLIC from the site for the previous 12 consecutive months to show conformance with *40 CFR 190*. Doses shall be calculated in accordance with the *Offsite Dose Calculation Manual*.

The semiannual effluent report shall also include a summary of each type of solid radioactive waste shipped offsite for burial or final disposal during the report period. This summary shall include the following information for each type of waste:

a. Type of waste (e.g., spent resin, compacted dry waste, irradiated components, etc.).

b. Solidification agent (e.g., cement).

c. Total curies.

d. Total volume and typical container volumes.

e. Principal radionuclides (those greater than 10% of total activity).

f. Types of containers used (e.g., LSA, Type A, etc.).

The semiannual effluent report shall include the following information for all unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents:

a. A description of the event and equipment involved.

b. Cause(s) for the unplanned release.

c. Actions taken to prevent recurrence.

d. Consequences of the unplanned release.

Any changes to the *RADIOLOGICAL EFFLUENT MONITORING* and *OFFSITE DOSE CALCULATION MANUAL (REMODCM)* and *Process Control Program (PCP)* shall be submitted to the Commission in the form of a complete copy of the entire REMM, ODCM, or PCP, as appropriate, as a part of or concurrent with the *Semiannual Radioactive Effluent Release Report* for the period of the report in which any change was made.

** In lieu of submission with the *Radioactive Effluent Release Report*, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

SECTION II

OFFSITE DOSE

CALCULATION MANUAL

FOR THE

MILLSTONE NUCLEAR POWER STATION

UNIT NOS. 1, 2, & 3

DOCKETS: No. 50-245
50-336
50-423

July 1990
Revision 2

OFFSITE DOSE CALCULATION MANUAL

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APPENDICES

A. INTRODUCTION

The purpose of this manual is to provide the parameters and methods 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 *Radiological Effluent Monitoring Manual*. 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 methods 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*.

The basis for some of the factors in this manual are included as appendices to this manual. Supplemental information on environmental sample locations is provided in an additional appendix.

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 are the methods to be used in performance of the surveillance requirements.

Most of the calculations in this manual have several 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. NUSCO Radiological Assessment Branch may perform these more detailed calculations.

This manual is written common to all three units since some release pathways are shared and there are also site release limits involved. These facts make it impossible to completely separate the three units.

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 Director 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 - Whole Body Dose

a. Method 1 - Any Unit

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

Step 2 Determine C_H which is the total curies of tritium released during the calendar quarter.

Step 3 Determine D_{QW} which is the quarterly dose to the whole body in mrem.

For Unit 1:

$$D_{QW} = 1.0\ C_F + 5.6 \times 10^{-7}\ C_H$$

For Units 2 and 3:

$$D_{QW} = 2 \times 10^{-2}\ C_F + 5.6 \times 10^{-7}\ C_H$$

Step 4 If D_{QW} is greater than 0.5 mrem, go to *Method 2.*

Note: See *Appendix A* for derivation of these factors. For Unit 1, the dose contribution from tritium can be neglected since it has never contributed to more than 2% of the whole body doses.

b. Method 2 - Any Unit

If the calculated dose using Method 1 is greater than 0.5 mrem, use the NRC computer code LADTAP II 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 II.*

C.2 Quarterly - Maximum Organ Dose

a. Method 1 - Any Unit

Step 1 Determine C_F which is 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} which equals the quarterly dose to the maximum organ in mrem.

For Unit 1:

$$D_{QO} = 2.1\ C_F$$

For Units 2 and 3:

$$D_{QO} = 0.2\ C_F$$

(See *Appendix B* for derivation of these factors)

Step 3 If D_{QO} is greater than 2 mrem, go to *Method 2*.

b. **Method 2 - Any 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 II.*

C.3 Annual - Whole Body Dose - Any Unit

Determine D_{YW} which equals dose to the whole body for the calendar year as follows:

$D_{YW} = \Sigma D_{QW}$, where the sum is over the first quarter through the present quarter whole body doses.

The following should be used as D_{QW}:

(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_{YW} is greater than 3 mrem and any D_{QW} determined as in *Section C.1* was not calculated using *Method 2* of that section, recalculate D_{QW} using *Method 2* if this could reduce D_{YW} to less than 3 mrem.

C.4 Annual - Maximum Organ Dose - Any Unit

Determine D_{YO} which is the 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} is greater than 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

a. Whole Body & Maximum Organ - Unit 1

Step 1 Determine D'_{MW} which is the whole body dose from the last typical* previously completed month as calculated per the methods in *Section C.1*.

Step 2 Determine D'_{MO} which is the maximum organ dose from the last typical* previously completed month as calculated per the methods in *Section C.1*.

Step 3 Estimate R_1 which is the 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 which is the ratio of estimated primary coolant activity for the present month to that for the past month.

Step 5 Determine F which is the factor to be applied to estimated ratio of final curie released 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-0016 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_{MW} which is the estimated monthly whole body dose as follows:

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

Step 7 Determine D^E_{MO} which is the 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.

If the last typical month's doses were calculated using LADTAP II (or similar methodology), also multiply the LADTAP doses by R_5 where R_5 = total dilution flow from LADTAP run divided by estimated total dilution flow.

b. Whole Body & Maximum Organ - Unit 2 and Unit 3

Step 1 Determine D'_{MW} which is the whole body dose from the last typical* previously completed month as calculated per the methods in *Section C.1*.

Step 2 Determine D'_{MO} which is the 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 which is the 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 which is the ratio of estimated volume of steam generator blowdown to be released in present month to the volume released in the past month.

Step 5 Determine F_1 which is the fraction of curies released last month coming from steam generator blowdown.

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

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

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

Step 8 Determine F_2 which is the factor to be applied to estimate ratio of final curie released 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-0017 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_{MW} which equals estimated monthly total body dose as follows:

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

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

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

C.6 Quarterly Dose Calculations for Semiannual Radioactive Effluent Report

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

D. GASEOUS DOSE CALCULATIONS

D.1. 10CFR20 Limits ("Instantaneous")

a. Instantaneous Noble Gas Release Rate Limits - All Units

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

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Where:

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

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

Q_3 = Noble gas release rate from MP3 Vent (µCi/sec)

See *Appendix D* for derivation of this limit.

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

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 - All Units

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

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

Q_{I3} = Release rate of I-131 from MP3 Vent - (µCi/sec)*

Q_{H1} = Release rate of tritium from MP1 Stack - (µCi/sec)

Q_{H2} = Release rate of tritium from MP2 Vent - (µCi/sec)*

Q_{H3} = Release rate of tritium from MP3 Vent - (µCi/sec)*

Q_{P1} = Release rate of total particulates with half-lives greater than 8 days from the MP1 Stack (µCi/sec)

Q_{P2} = Release rate of total particulates with half-lives greater than 8 days from the MP2 Vent (µCi/sec)

Q_{P3} = Release rate of total particulates with half-lives greater than 8 days from the MP3 Vent (µCi/sec)

*Includes releases via the steam generator blowdown tank vent.

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

i. ***Method 1***

Assuming milk animals on pasture, harvest season, and milk animals at maximum resident D/Q locations:

$$1.17\,Q_{I1} + 43.5\,Q_{I2} + 43.5\,Q_{I3} + 3.47 \times 10^{-7}\,Q_{H1} + 3.27 \times 10^{-5}\,Q_{H2} + 3.27 \times 10^{-5}\,Q_{H3} \leq 1$$

ii. ***Method 2***

(a) First Quarter - Inhalation doses only

$$5.5 \times 10^{-4}\,Q_{I1} + 5.1 \times 10^{-2}\,Q_{I2} + 5.1 \times 10^{-2}\,Q_{I3} + 4.4 \times 10^{-8}\,Q_{H1} + 4.2 \times 10^{-6}\,Q_{H2} + 4.2 \times 10^{-6}\,Q_{H3} \leq 1$$

(b) Fourth Quarter - Inhalation and milk doses

$$1.13\,Q_{I1} + 42\,Q_{I2} + 42\,Q_{I3} + 2.11 \times 10^{-7}\,Q_{H1} + 1.98 \times 10^{-5}\,Q_{H2} + 1.98 \times 10^{-5}\,Q_{H3} \leq 1$$

(c) If it can be verified that milk and/or vegetation doses need not be considered, use one of the above, or for

Inhalation and vegetation doses only:

$$4.0 \times 10^{-2}\,Q_{I1} + 1.5\,Q_{I2} + 1.5\,Q_{I3} + 1.8 \times 10^{-7}\,Q_{H1} + 1.7 \times 10^{-5}\,Q_{H2} + 1.7 \times 10^{-5}\,Q_{H3} \leq 1$$

iii. ***Method 3***

If it can be verified that the *Appendix D.1* D/Q data for milk animals is acceptable (Note: If not, see guidance in *Appendix D*):

(a) Second and Third Quarter - All Pathways

$$0.3\,Q_{I1} + 3.2\,Q_{I2} + 3.2\,Q_{I3} + 3.5 \times 10^{-7}\,Q_{H1} + 3.3 \times 10^{-5}\,Q_{H2} + 3.3 \times 10^{-5}\,Q_{H3} \leq 1$$

(b) Fourth Quarter - Inhalation and milk pathways

$$0.27\,Q_{I1} + 1.7\,Q_{I2} + 1.7\,Q_{I3} + 2.1 \times 10^{-7}\,Q_{H1} + 2.0 \times 10^{-5}\,Q_{H2} + 2.0 \times 10^{-5}\,Q_{H3} \leq 1$$

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

i. ***Method 1***

Assuming milk animals on pasture, harvest season, and milk animals at maximum resident D/Q locations:

$$0.41\,Q_{P1} + 15.1\,Q_{P2} + 15.1\,Q_{P3} + 3.5 \times 10^{-7}\,Q_{H1} + 3.3 \times 10^{-5}\,Q_{H2} + 3.3 \times 10^{-5}\,Q_{H3} \leq 1$$

ii. ***Method 2***

(a) First Quarter - Inhalation doses only

$$5.5 \times 10^{-4}\,Q_{P1} + 5.1 \times 10^{-2}\,Q_{P2} + 5.1 \times 10^{-2}\,Q_{P3} + 4.4 \times 10^{-8}\,Q_{H1} + 4.2 \times 10^{-6}\,Q_{H2} + 4.2 \times 10^{-6}\,Q_{H3} \leq 1$$

(b) Fourth Quarter - Inhalation and milk doses

$$0.36\,Q_{P1} + 13.4\,Q_{P2} + 13.4\,Q_{P3} + 2.1 \times 10^{-7}\,Q_{H1} + 2.0 \times 10^{-5}\,Q_{H2} + 2.0 \times 10^{-5}\,Q_{H3} \leq 1$$

(c) If it can be verified during other times of the year that milk and/or vegetation doses need not be used, use one of the above, or use *Appendix D* to develop factors.

iii. ***Method 3***

If it can be verified that the *Appendix D.1* D/Q data for milk animals is acceptable (Note: If not, see guidance in *Appendix D*), then use this method.

(a) Second and Third Quarters:

$$0.14\,Q_{P1} + 2.3\,Q_{P2} + 2.3\,Q_{P3} + 3.5 \times 10^{-7}\,Q_{H1} + 3.3 \times 10^{-5}\,Q_{H2} + 3.3 \times 10^{-5}\,Q_{H3} \leq 1$$

(b) Fourth Quarter (no vegetation):

$$0.09\,Q_{P1} + 0.57\,Q_{P2} + 0.57\,Q_{P3} + 2.1 \times 10^{-7}\,Q_{H1} + 2.0 \times 10^{-5}\,Q_{H2} + 2.0 \times 10^{-5}\,Q_{H3} \leq 1$$

iv. ***Method 4***

Above methods assume a conservative nuclide mix. If necessary, utilize the methods in *Appendix D* and *NUREG-0133* to develop factors for the actual isotopes released.

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

D.2. 10 CFR50 Appendix I - Noble Gas Limits

a. Quarterly Air Dose - Method 1 - All Units

Step 1

Determine C_{N1} which equals the total curies of noble gas released from Unit 1 during the calendar quarter.

Step 2

Determine C_{N2} which equals the 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 C_{N3} which equals the total curies of noble gas released from Unit 3 during the calendar quarter. Include all sources - ventilation, containment vacuum system, and gaseous radwaste system.

Step 4

Determine D_{QG1} which equals the quarterly gamma air dose from Unit 1 (mrad).

$$D_{QG1} = 9.3 \times 10^{-5} C_{N1}{}^{*}$$

Step 5

Determine D_{QB1} which equals the quarterly beta air dose from Unit 1 (mrad).

$$D_{QB1} < 9.3 \times 10^{-7} C_{N1}{}^{*}$$

Step 6

Determine D_{QG2} which equals the quarterly gamma air dose from Unit 2 (mrad).

$$D_{QG2} = 6.3 \times 10^{-4} C_{N2}{}^{*}$$

Step 7

Determine D_{QB2} which equals the quarterly beta air dose from Unit 2 (mrad).

$$D_{QB2} = 1.7 \times 10^{-3} C_{N2}{}^{*}$$

Step 8

Determine D_{QG3} which equals the quarterly gamma air dose from Unit 3 (mrad).

$$D_{QG3} = 6.3 \times 10^{-4} C_{N3}{}^{*}$$

Step 9

Determine D_{QB3} which equals the quarterly beta air dose from Unit 3 (mrad).

$$D_{QB3} = 1.7 \times 10^{-3} C_{N3}^{*}$$

Step 10

If D_{QG1}, D_{QG2}, or D_{QG3} are greater than 1.6 mrad; or D_{QB1}, D_{QB2}, or D_{QB3} are greater than 3.3 mrad, go to *Method 2*.

*See *Appendix D* for derivation of factors.

b. **Quarterly Air Dose - Method 2 - All Units**

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

The 3rd quarter 1980 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 one-half the Technical Specification limit, use real-time meteorology.

Unit 2, 3 - For MP2 and MP3 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:

$X/Q = 0.81 \times 10^{-5}$ sec/m^3

(See Appendix D)

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

If the calculated air dose exceeds one-half the quarterly Technical Specification limit, use real-time meteorology.

c. **Annual Air Dose Limit Due to Noble Gases - All Units**

Determine D_{YG1}, D_{YG2}, D_{YG3}, D_{YB1}, D_{YB2} and D_{YB3} = gamma air dose and beta air dose for the calender year for Unit 1, 2 or 3 as follows:

$$D_{YG1} = \Sigma D_{QG1};\ D_{YB1} = \Sigma D_{QB1};\ D_{YG2} = \Sigma D_{QG2};\ D_{YB2} = \Sigma D_{QB2};\ D_{YG3} = \Sigma D_{QG3};\ D_{YB3} = \Sigma D_{QB3}.$$

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 *Section D.5* for the *Semiannual 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 $D_{YG1, 2,}$ or $_{3,}$ are greater than 10 mrad or $D_{YB1, 2,}$ or $_{3,}$ are greater than 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. <u>10 CFR50 Appendix I - Iodine and Particulate Doses</u>

Doses from tritium (for Methods 1-4 only) for Unit 1 may be neglected if the total tritium curies from the quarter are less than 500.

a. <u>Quarterly Doses - Unit 1</u>

(1) <u>Method 1</u> - <u>Unit 1</u>

<u>Step 1</u> - Determine C_I which is the total curies of I-131 released in gaseous effluents from Unit 1 during the quarter.

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

<u>Step 3</u> - Determine C_H which is the total curies of tritium released in gaseous effluents from Unit 1 during the quarter.

<u>Step 4</u> - Determine D_{QT} which equals the quarterly thyroid dose as follows:

$$D_{QT} = 1.22 \times 10^{2}\, C_I + 2.0 \times 10^{-5}\, C_H$$

<u>Step 5</u> - Determine D_{QO} which equals the quarterly dose to the maximum organ other than the thyroid:

$$D_{QO} = 42.3\, C_P + 2.0 \times 10^{-5}\, C_H$$

<u>Step 6</u> - The maximum organ dose is the greater of D_{QT} or D_{QO}. If it is greater than 2.5 mrem, go to *Method 2*.

(2) <u>Method 2</u> - <u>Unit 1</u>

Doses from vegetation consumption can be neglected during the 1st and 4th quarters and doses from milk consumption can be neglected during the 1st quarter. These time frames can be extended for short term releases (batch releases and weekly continuous, if necessary) if it can be verified that the milk animals were not on pasture and/or vegetation is not available for harvest. Therefore, calculate doses to the thyroid and maximum organ for pathways that actually exist. Sum pathways if necessary.

Perform *Steps 1 through 3* as in *Method 1*, above. Then:

<u>Step 4</u> -

i. Inhalation Pathway

$$D_{QT} = 3.2 \times 10^{-2}\, C_I + 2.6 \times 10^{-6}\, C_H$$

$$D_{QO} = 3.2 \times 10^{-2}\, C_P + 2.6 \times 10^{-6}\, C_H$$

ii. Vegetation Pathway

$$D_{QT} = 4.1\, C_I + 8.0 \times 10^{-6}\, C_H$$
$$D_{QO} = 4.9\, C_P + 8.0 \times 10^{-6}\, C_H$$

iii. Milk Pathway

$$D_{QT} = 118\, C_I + 9.8 \times 10^{-6}\, C_H$$
$$D_{QO} = 38\, C_P + 9.8 \times 10^{-6}\, C_H$$

Sum above pathways, as appropriate (*Note*: sum of all three pathways is *Method 1*)

Step 5 - The maximum organ dose is the greater of D_{QT} or D_{QO}. If it is greater than 2.5 mrem, go to the next method.

(3) **Method 3** - Unit 1

After reviewing the existing cow and goat farms, if it can be determined that the 1983-1987 D/Q data is acceptable (Note: If not, see guidance in *Appendix D*), then follow *Method 2* above, *except* for *iii*. where milk pathway dose is:

$$D_{QT} = 28\, C_I + 9.8 \times 10^{-6}\, C_H$$
$$D_{QO} = 8.9\, C_P + 9.8 \times 10^{-6}\, C_H$$

Note: During the 2nd and 3rd quarters also add (to the above) the Inhalation and Vegetation Pathways from *Step 4 of Method 2*; during the 4th quarter add Inhalation and Milk (above) *only*.

(4) **Method 4** - 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*:

$X/Q = 6.1 \times 10^{-8}$ sec/m^3
$D/Q = 5.9 \times 10^{-9}$ m^{-2} (Milk and Vegetation) and/or
$D/Q = 1.4 \times 10^{-9}$ m^{-2} (If 1983-1987 D/Q data is acceptable for existing milk locations. If not, see guidance in *Appendix D*.)

Use the Inhalation, Milk and Vegetation pathways (If applicable) in totaling the dose. If the maximum organ dose is greater than 3.8 mrem, go to *Method 5*.

(5) **Method 5** - Unit 1

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

b. **Quarterly Doses - Unit 2 and Unit 3**

(1) **Method 1 - Unit 2 and Unit 3**

Step 1 - Determine C_I which is the total curies of I-131 in gaseous effluents from Unit 2 or 3 during the quarter.

Step 2 - Determine C_P which is the total curies of particulates with half-lives greater than 8 days released in gaseous effluents from Unit 2 or 3 during the calendar quarter.

Step 3 - Determine C_H which is the total curies of tritium released in gaseous effluents from Unit 2 or 3 during the calendar quarter.

Step 4 - Determine D_{QT} which equals the quarterly thyroid dose as follows:

$$D_{QT} = 3.1 \times 10^3 C_I + 2.6 \times 10^{-3} C_H$$

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

$$D_{QO} = 1.1 \times 10^3 C_P + 2.6 \times 10^{-3} C_H$$

Step 6 - The maximum organ dose is the greater of D_{QT} or D_{QO}. If greater than 2.5 mrem, go to *Method 2*.

(2) **Method 2 - Unit 2 and Unit 3**

Doses from vegetation consumption can be neglected during the 1st and 4th quarters and doses from milk consumption can be neglected during the 1st quarter. These time frames can be extended for short term releases (batch releases and weekly continuous, if necessary) if it can be verified that the milk animals were not on pasture and/or vegetation was not available for harvest. Therefore, calculate doses to the thyroid and maximum organ for pathways that actually exist. Sum pathways if necessary.

Perform *Steps 1 through 3* as in *Method 1*, then:

Step 4 -

i. **Inhalation Pathway**

$$D_{QT} = 4.1 C_I + 3.3 \times 10^{-4} C_H$$

$$D_{QO} = 4.1 C_P + 3.3 \times 10^{-4} C_H$$

ii. **Vegetation Pathway**

$$D_{QT} = 105 C_I + 1.0 \times 10^{-3} C_H$$

$$D_{QO} = 124 C_P + 1.0 \times 10^{-3} C_H$$

iii. **Milk Pathway**

$$D_{QT} = 3000 C_I + 1.3 \times 10^{-3} C_H$$

$$D_{QO} = 951 C_P + 1.3 \times 10^{-3} C_H$$

Sum above pathways, as appropriate (*Note*: sum of all three pathways is *Method 1*)

Step 5 - The maximum organ dose is the greater of D_{QT} or D_{QO}. If it is greater than 2.5 mrem, go to the next method.

(3) **Method 3 - Unit 2 and Unit 3**

After reviewing the existing cow and goat farms, if it can be determined that the 1983-1987 D/Q data is acceptable (Note: If not, see guidance in *Appendix D*), then follow *Method 2*, above, except for *iii*, where the milk pathway dose is:

$$D_{QT} = 122\,C_I + 1.3 \times 10^{-3}\,C_H$$

$$D_{QO} = 40\,C_P + 1.3 \times 10^{-3}\,C_H$$

Note: During the 2nd and 3rd quarters also add (to the above) the Inhalation and Vegetation Pathways from *Step 4 of Method 2*; during the 4th quarter add Inhalation and Milk (above) *only*.

(4) **Method 4 - Unit 2 and Unit 3**

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*:

$X/Q = 8.1 \times 10^{-6}$ sec/m^3

$D/Q = 1.5 \times 10^{-7}$ m^{-2} (Milk and Vegetation) and/or

$D/Q = 6.1 \times 10^{-9}$ m^{-2} (If 1983-1987 D/Q data is acceptable for existing milk locations. If not, see guidance in *Appendix D*.)

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 or 3.

Use the Inhalation, Milk and Vegetation pathways (if applicable) in totaling the dose. If the maximum organ dose is greater than 3.8 mrem, go to *Method 5*.

(5) **Method 5 - Unit 2**

Use the GASPAR code with the actual locations, real-time meteorology 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.

(5) **Method 5 - Unit 3**

Use the GASPAR code with the actual locations, real-time meteorology and the pathways which actually exist at these locations. The code should be run separately for ventilation, process gas, containment vacuum system, aerated ventilation and containment purges.

D.3. 10 CFR50 Appendix I - Iodine and Particulate Doses

c. Annual Doses - All Units

Determine D_{YT1}, D_{YT2}, D_{YT3}, D_{YO1}, D_{YO2}, and D_{YO3} which are the thyroid and maximum organ doses for the calendar year for Units 1, 2, and 3 respectively, as follows:

$D_{YT1,\,2,\,or\,3} = \Sigma\, D_{QT}$ = sum of the quarterly thyroid doses where the sum is over the first quarter through the present quarter.

$D_{YO1,\,2\,or\,3} = \Sigma\, D_{QO}$ = sum of the quarterly maximum organ doses where the sum is over the first quarter through the present quarter.

The following guidelines should be used for D_{QT} and D_{QO}:

(1) If the detailed quarterly dose calculations required per *Section D.5* for the *Semiannual 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_{YT} and/or D_{YO} are greater than 15 mrem and 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

a. Unit 1

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

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 the expected maximum power for the month.

R = Estimated curie reduction factor from air ejector to stack via the 30 minute (actual time is approximately 55 minutes) holdup line (in decimal fraction).

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

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

$= 9.3 \times 10^{-5}$ mrad/Ci* x Q Ci/secx R x d (day) x 8.6×10^{4} sec/day.

D^E_{MG} (mrad) $= 8.0 \times Q \times R \times d$

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

D^E_{MB} (mrad) $< 0.08 \times Q \times R \times d$

**See Appendix D for dose factor*

(2) Due to Ventilation System Releases

i. ***Method 1***

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

Step 2 - Estimate R_1 which is the expected reduction factor for the HEPA filter. Typically this should be 100 *(see NUREG-0016 or 0017 for additional guidance).*

Step 3 - Estimate R_2 which is the fraction of the time which the equipment was inoperable during the last quarter.

Step 4 - Estimate R_3 which is the fraction of the time which the equipment is expected to be inoperable during the next month.

Step 5 - Determine D^E_{MO} which is the estimated monthly dose to the maximum organ.

$$D^E_{MO} = 1/3\, R_1\, (1.01 - R_2)\, (R_3 + 0.01)\, D_{QO}$$

ii. ***Method 2***

If necessary, estimate the curies expected to be released for the next month and applicable method for dose calculation from *Section D.3.a**.

* - *Section D.3.b* for Unit 2 or Unit 3.

b. Unit 2

(1) Due to Gaseous Radwaste Treatment System

Step 1 - Estimate CE_N which equals the number of curies of noble gas to be released from the waste gas storage tanks during the next month.

Step 2 - Determine DE_{MG} which is the estimated monthly gamma air dose.

$$DE_{MG} \text{ (mrad)} = 9.3 \times 10^{-5}\, CE_N$$

(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 DE_{MB} which is the estimated monthly beta air dose.

$$DE_{MB} \text{ (mrad)} < 9.3 \times 10^{-7}\, CE_N$$

(2) Due to Steam Generator Blowdown Tank Vent

i. ***Method 1***

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

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

Step 3 - Determine DE_{MO} which is the estimated monthly dose to the maximum organ.

$$DE_{MO} = 1/3\, R_1\, D_{QT}$$

ii. *Method 2*

If necessary, estimate the curies expected to be released for the next month and applicable method for dose calculation from *Section D.3.b.*

(3) Due to Ventilation Releases*

Use the same method as given in *Section D.4.a.(2).*

c. Unit 3

(1) Due to Radioactive Gaseous Waste System

Use the same method as given in *Section D.4.b.(1).* However, instead of waste storage tanks use the reactor plant gaseous vents. The activity from this pathway increases when the process waste gas system is out of service.

(2) Due to Steam Generator Blowdown Tank Vent

Use the same method as given in *Section D.4.b.(2).*

(3) Due to Ventilation Releases*

Use the same method as given in *Section D.4.a.(2).*

D.5. Quarterly Dose Calculations for Semiannual Report

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

*Since dose projections are only required if the treatment specified in *Section D* of the Radiological Effluent Monitoring Manual are not operating, the monthly gamma and beta air dose projections are not required for ventilation releases.

D.6. Compliance with 40 CFR190

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, 2, and 3.

b. Liquid Releases from Units 1, 2, and 3.

c. Direct Radiation from the Site.

Calculations and detailed surveys* indicate that the only significant contributor to off-site exposure from this source is "Skyshine" from the Unit 1 Turbine Building. The location of maximum dose is that of the critical fisherman. Listed below are the assumptions used for the calculation of these doses:

****CALCULATION OF SKYSHINE CONTRIBUTION TO CRITICAL FISHERMAN**

(1) Based upon data obtained by Don Landers (MP Env. Lab) from the State of CT Department of Environmental Protection (DEP) records on lobster catches:

Annual average of 3.5 - 4.5 days between trips to each lobster basket

(2) Therefore, there are 104 trips per year.

(3) Conservatively, assuming it takes one hour in the area to check all the baskets, this results in 104 hours around the intake structures area.

(4) Maximum dose rate in the area is normally 65 µR/hr.

(5) Average dose rate is approximately one-half of the maximum.

(6) Therefore, annual dose to critical lobsterman is approximately 104 hours/year x 65 µR/hr x 1/2 = 3.4 mrem.

(7) Therefore dose/month =

$$3.4 \frac{\text{mrem}}{\text{year}} \times \frac{\text{year}}{12\ \textit{months}} \times \text{Unit 1 Capacity Factor} = 0.3 \frac{\text{mrem}}{\textit{month}} \times \text{Unit 1 Capacity Factor}$$

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

References:

* Memo to P. L. Tirinzoni from J. W. Doroski and C. A. Flory, Skyshine Evaluation at Millstone Unit #1, NE-87-RA-1033, December 8, 1987

** This should be the most limiting individual since it is expected that even though fishermen may spend more time near the area, they normally fish in an area of ~1 µR/hr.

E. LIQUID MONITOR SETPOINTS

E.1 Unit 1 Liquid Radwaste Effluent Line

The trip/alarm setting on the Unit 1 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 of these parameters, an alarm/trip setpoint will be determined prior to the release of each batch. The following method 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.:

For Nuclides Other Than Noble Gases*:

$$R_1 = \textit{Required Reduction Factor} = 1/\Sigma\left(\frac{\mu Ci/ml \textit{ of nuclide } i}{MPC \textit{ of nuclide } i}\right)$$

For Noble Gases:

$$R_2 = \textit{Required Reduction Factor} = 1/\Sigma\ \frac{\mu Ci/ml \textit{ of noble gases}}{2 \times 10^{-4}\ \mu Ci/ml}$$

$$= 2 \times 10^{-4} / \Sigma\ \mu Ci/ml \textit{ of noble gases}$$

$$R = \textit{the smaller of } R_1 \textit{ or } R_2$$

* In lieu of determining the required reduction factor for noble gases, conservatism is allowed. For example, calculate the maximum concentration of noble gases that can be discharged from any tank.

Assuming:

Maximum discharge rate = 350 gpm

Minimum dilution flow = 110,000 gpm *(1 circulating pump & 1 service water pump)*

$$\text{Maximum noble gas Concentration} \times \frac{350\ \text{gpm}}{110{,}000\ \text{gpm}} = 2 \times 10^{-4}\ \mu\text{Ci/ml}$$

Therefore,

Maximum concentration = 0.063 µCi/ml

Step 2 Determine the existing dilution flow which is D

D = #circulating water pumps x 100,000 gpm + # service water pumps x 10,000 gpm.

Step 3 Determine the allowable discharge flow which is F

F = 0.1 x R x D

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

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

Step 5 Using the current calibration response factor, determine the "cps" corresponding to two times the total µCi/ml determined in *Step 4 (Note 1)*. This value or that corresponding to 9.4×10^{-5} µCi/ml *(Note 2)*, whichever is greater, plus background is the trip setpoint. For the latter setpoint, independent valve verification should be performed.

Note 1: If discharging at the allowable discharge rate as determined in *Step 3*, this would yield a discharge concentration corresponding to 20% of the Technical Specification limit.

Note 2: This value is based upon worst case conditions, assuming maximum discharge flow (350 gpm), minimum dilution water flow (110,000 gpm for MP1) and an assumed worst case mix of nuclides (3×10^{-7}). This value may be increased by factors to account for the actual discharge flow and actual dilution flow. This will assure that low level releases are not terminated due to small fluctuations in activity. However, to verify that the correct tank is being discharged when using this value, independent valve verification should be performed. Administrative controls should be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained.

Step 6 This allowable discharge flow rate calculated in *Step 3* may be increased by up to a factor of 5 with appropriate administrative controls (e.g., for Unit 2, insure other release points may not cause MPC's to be exceeded).

E.2 Unit 1 Reactor Building Service Water Effluent Line

The MP1 Reactor Building 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

Similar to the Unit 1 liquid discharge line, the setpoints on the Unit 2 liquid waste effluent line depend 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 of these parameters, an alarm/trip setpoint will be determined prior to the release of each batch. The following method 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.:

For Nuclides Other Than Noble Gases:

$$R_1 = \textit{Required Reduction Factor} = 1/\Sigma_i \left(\frac{\mu Ci/ml \text{ of nuclide } i}{MPC \text{ of nuclide } i} \right)$$

For Noble Gases*:

$$R_2 = \textit{Required Reduction Factor} = 1/\Sigma \frac{\mu Ci/ml\ of\ noble\ gases}{2 \times 10^{-4}\ \mu Ci/ml}$$

$$= 2 \times 10^{-4}/\Sigma\ \mu Ci/ml\ of\ noble\ gases$$

$$R = \textit{the smaller of } R_1 \textit{ or } R_2$$

* In lieu of determining the required reduction factor for noble gases, conservatism is allowed. For example, calculate the maximum concentration of noble gases that can be discharged from any tank.

Assuming:

Maximum discharge rate = 350 gpm

Minimum dilution flow = 274,000 gpm *(2 circulating pumps & 1 service water pump)*

$$\text{Maximum noble gas Concentration} \times \frac{350\ gpm}{274{,}000\ gpm} = 2 \times 10^{-4}\ \mu Ci/ml$$

Therefore,

Maximum concentration = 0.15 µCi/ml

Step 2 Determine the existing dilution flow which equals D

D = circulating water pumps x 135,000 gpm + # service water pumps x 4,000 gpm.

Step 3 Determine the allowable discharge flow which equals F

F = 0.1 x R x D

Note that discharging at this flow rate would yield a discharge concentration corresponding to 10% of the *Technical Specification Limit* due to the safety factor of 0.1.

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

Step 5 The Alert setpoint will be 1.5 times the total µCi/ml determined in *Step 4*, plus background. This step is not necessary for the clean or aerated liquid waste monitors.

Step 6 Using the current calibration response factor, determine the "cpm" corresponding to two times the total µCi/ml determined in *Step 4 (Note 1)*. This value or that corresponding to 2.2 x 10^{-4} µCi/ml *(Note 2)*, whichever is greater, plus background is the trip setpoint. For the latter setpoint, independent valve verification should be performed.

Note 1: If discharging at the allowable discharge rate as determined in *Step 3*, this would yield a discharge concentration corresponding to 20% of the Technical Specification limit.

<u>*Note 2:*</u> This value is based upon worst case conditions, assuming maximum (350 gpm) discharge flow, minimum dilution water flow (274,000 gpm for MP2) and an assumed worst case mix of nuclides (3×10^{-7} - I-131 MPC). This will assure that low level releases are not terminated due to small fluctuations in activity. However, to verify that the correct tank is being discharged when using this value, independent valve verification should be performed. This value may be increased by factors to account for the actual discharge flow and actual dilution flow; however, controls should be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained.

<u>Step 7</u> This allowable discharge flow rate calculated in *Step 3* may be increased by up to a factor of 5 with appropriate administrative controls (e.g., for Unit 2, insure other release points may not cause MPC's to be exceeded).

E.4 <u>Unit 2 Aerated Liquid Radwaste Effluent Line and Condensate Polishing Facility Waste Neutralization Sump Effluent Line</u>

Same as E.3 for Clean Liquid Monitor and the Condensate Polishing Facility (CPF) Waste Neutralization Sump monitor except the CPF monitor has the capability to readout in CPM or µCi/ml. For the CPF Waste Neutralization Sump monitor, use a default setpoint if no chemistry grab samples are required. This default should be the lower of: 2 times background or the value as specified in E.3.

E.5 <u>Unit 2 Steam Generator Blowdown</u>

Assumptions used in determining the Alarm setpoint for this monitor are:

a. Maximum possible total S. G. blowdown flow rate = 600 gpm.

b. Minimum possible circulating water dilution flow during periods of blowdown = 270,000 gpm (2 circulating water pumps) + 4,000 gpm (1 service water pump) = 274,000 gpm.

c. The release rate limit is conservatively set at 50% of the *10CFR Part 20* limit for I-131 ($0.5 \times 3 \times 10^{-7}$ µCi/ml = 1.5×10^{-7} µCi/ml)*.

d. Background can be added after above calculations are performed.

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

$$\textit{Alarm } (\mu Ci/ml) = \frac{274{,}000}{600} \times 1.5 \times 10^{-7} + \textit{background}^{**} = 6.8 \times 10^{-5}\ \mu Ci/ml + \textit{background}$$

The latest monitor calibration curve should be used to determine the alarm setpoint in cpm corresponding to 6.8×10^{-5} µCi/ml.

This setpoint may be increased through proper administrative controls if the steam generator blowdown rate is maintained less than 600 gpm and/or more than 2 circulating water pumps and 1 service water pump are available. The percent increase would correspond to the ratio of flows to those assumed above or:

$$Alarm\,(\mu Ci/ml) = 6.8 \times 10^{-5}\,\mu Ci/ml \times \frac{circulating\ \&\ service\ water\ flow\ (gpm)}{274{,}000} \times \frac{600}{S/G\ Blowdown\ (gpm)}$$

$$+\ Background = \frac{1.5 \times 10^{-7}\,\mu Ci/ml \times circulating\ \&\ service\ water\ flow\ (gpm)}{total\ S/G\ Blowdown\ (gpm)} + Background$$

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 I-131 MPC value, the identified MPC values for unrestricted area may be used.

** Background of monitor at monitor location (i.e., indication provided by system monitor with no activity present in the monitored system)

E.6 Unit 2 Condenser Air Ejector

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. This monitor also provides rapid indication of an increased leakage rate from the primary to secondary system (i.e., steam generator tube leak).

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

This monitor setpoint can be two times the current reading as long as this reading corresponds to a reactor coolant system primary to secondary leakage rate less than 0.05 gpm ($2 \times 0.05 < 0.1$, which is the limit listed in *Technical Specification 3.4.6.2*) and current blowdown activity at that time (from a grab sample) is less than one-half the *10CFR20 Table 2 Column 2 MPC's* (6.8×10^{-5} µCi/ml from *E.5* above. As above, this can be revised to be more realistic.). The setpoint may be increased by a factor greater than two times the current reading as long as the reactor coolant system primary-to-secondary leakage rate is less than the 0.1 gpm leakage divided by this same factor and the current blowdown activity is less than the MPCs divided by this same factor.

E.7 Unit 2 Reactor Building Closed Cooling Water

Assumptions used in determining the Alarm setpoint for this monitor are:

a. Maximum flow from primary makeup water is 400 gpm.

b. Minimum circulating water dilution flow is 135,000 gpm (1 circulating water pump).

c. The release rate limit is conservatively set at 50% of the *10CFR Part 20* limit for I-131 ($0.5 \times 3 \times 10^{-7}$ µCi/ml = 1.5×10^{-7} µCi/ml).

d. Background can be added after the above calculations are performed.

Therefore, the alarm setpoint (using the latest monitor calibration curve) should correspond to a concentration of:

Alarm (µCi/ml) = 135,000/400 x 1.5 x 10^{-7} + background*
= 5 x 10^{-5} µCi/ml + background

Note that the purpose of this monitor is to detect high activity that may occur between the weekly composite RBCCW samples. Hence, the maximum undetected dose consequence, assuming an unlikely 400 gpm leak, is:

5 x 10^{-5} µCi/ml x 400 gal/min x 168 hr/week x 60 min/hr x 3785 cc/gal
x Ci/10^{6} µCi = 0.8 Ci
0.8 Ci x 0.2 mrem/Ci = 0.16 mrem maximum organ

This dose is below limits and is an event that should barely, if ever, happen over the life of the plant.

* Monitor background at monitor location.

E.8 Unit 3 Liquid Waste Monitor

Similar to the Unit 1 liquid discharge line, the setpoints on the Unit 3 liquid waste monitor depend 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 of these parameters, the alert and alarm setpoints will be determined prior to the release of each batch. The following method 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.:

For Nuclides Other Than Noble Gases:

$$R_1 = Required\,Reduction\,Factor = 1/\Sigma_i \left(\frac{\mu Ci/ml\ of\ nuclide\ i}{MPC\ of\ nuclide\ i} \right)$$

For Noble Gases*:

$$R_2 = Required\,Reduction\,Factor = 1/\Sigma \frac{\mu Ci/ml\ of\ noble\ gases}{2 \times 10^{-4}\ \mu Ci/ml}$$

$$= 2 \times 10^{-4} / \Sigma\ \mu Ci/ml\ of\ noble\ gases$$

$$R = the\ smaller\ of\ R_1\ or\ R_2$$

* In lieu of determining the required reduction factor for noble gases, conservatism is allowed. For example, calculate the maximum concentration of noble gases that can be discharged from any tank.

Assuming:

Maximum discharge rate = 150 gpm

Minimum dilution flow = 300,000 gpm *(2 circulating pumps)*

$$\text{Maximum "allowable" Concentration} \times \frac{150\ \text{gpm}}{300{,}000\ \text{gpm}} = 2 \times 10^{-4}\ \mu\text{Ci/ml}$$

Therefore,

Maximum "allowable" concentration = 0.4 μCi/ml

Step 2 Determine the existing dilution flow which equals D

D = # circulating water pumps x 150,000 gpm + # service water pumps x 15,000 gpm.

Step 3 Determine the allowable discharge flow which equals F

F = 0.1 x R x D

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

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

Step 5 The alert setpoint will be 1.5 times the total μCi/ml determined in *Step 4*, plus background.

Step 6 The alarm setpoint will be two times the total μCi/ml determined in *Step 4 (Note 1)* or 2.2×10^{-4} *μCi/ml (Note 2)*, whichever is greater, plus background.

Note 1: If discharging at the allowable discharge rate as determined in *Step 3*, this Alarm setpoint would yield a discharge concentration corresponding to 20% of the Technical Specification limit.

Note 2: This value is based upon worst case conditions, assuming maximum discharge flow (150 gpm), minimum dilution water flow (2 circulating pumps and 2 service water pumps = 334,000 gpm), and of an assumed mix of nuclides as specified for an unidentified liquid release in *10CFR20* (1×10^{-7} μCi/ml). This will assure that low level releases are not terminated due to small fluctuations in activity causing valve closure upon high radiation alarm. However, to verify that the correct tank is being discharged, when using this value, independent valve verification should be performed. This value may be increased by factors to account for the actual discharge flow and actual dilution flow; however, administrative controls should be established to ensure that the allowable discharge flow is not exceeded and the dilution flow is maintained.

Step 7 The allowable discharge flow rate calculated in *Step 3* may be increased by up to a factor of 5 with appropriate administrative controls (to ensure other release points do not cause MPC's to be exceeded).

E.9 Unit 3 Regenerant Evaporator Effluent Line

The MP3 Regenerant Evaporator Monitor alert setting is approximately 1.5 times the normal reading and the alarm setting is 2 times the normal reading.

E.10 Unit 3 Waste Neutralization Sump Effluent Line

Same as *Section E.8*. Note that for this monitor, even though grab samples may not be required, setpoints still have to be utilized. In such cases, the default for low activity samples can be used.

E.11 Unit 3 Steam Generator Blowdown

The alarm setpoint for this monitor assumes:

a. Steam generator blowdown rate of 400 gpm (maximum blowdown total including weekly cleaning of generators - per 3-Part Memo from MP3 Reactor Engineering).

b. The release rate limit is conservatively set at 10% of the *10CFR Part 20* limit (0.1 times the I-131 MPC* for unrestricted areas which equals $0.1 \times 3 \times 10^{-7}$ µCi/ml).

c. Minimum possible circulating and service water dilution flow during periods of blowdown = 304,000 gpm (2 circulating water pumps) + 30,000 gpm (2 service water pumps) = 334,000 gpm.

d. Background can be added after above calculations are performed.

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

$$Alarm\ (\mu Ci/ml) = \frac{334{,}000}{400} \times 3 \times 10^{-8} + background = 2.5 \times 10^{-5}\ \mu Ci/ml + background$$

This setpoint may be increased through proper administrative controls if the steam generator blowdown rate is maintained less than 400 gpm and/or more than 2 circulating and 2 service water pumps are available. The amount of the increase would correspond to the ratio of flows to those assumed above or:

$$Alarm\ (\mu Ci/ml) = 2.5 \times 10^{-5}\ \mu Ci/ml \times \frac{circulating\ \&\ service\ water\ flow\ (gpm)}{334{,}000\ gpm} \times \frac{400\ gpm}{S/G\ Blowdown\ (gpm)}$$

$$+ Background = 3 \times 10^{-8}\ \mu Ci/ml \times \frac{circulating\ \&\ service\ water\ flow\ (gpm)}{total\ S/G\ Blowdown\ (gpm)} + Background$$

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 I-131 MPC value, the identified MPC values for unrestricted area may be used.

E.12 Unit 3 Turbine Building Floor Drains Effluent Line

The alarm setpoint for this monitor assumes:

a. Drinking water is not a real pathway at this site. Therefore the NRC code, LADTAP, is used to calculate the dose to the maximum individual.

b. The average annual discharge flow is 1.11×10^{-2} ft^3/sec (Process flow during sump pump operation is 50 gpm and pump normally operates less than 10% of the time for a conservative average flow of 5 gpm). There is no continuous additional dilution, therefore, discharge flow is conservatively assumed to equal dilution flow.

c. Near field dilution factor = 13,000.
Far field dilution factor = 32,000.
(Reference: Millstone 3 FSAR, Section 2.4.13)

d. Isotopic concentrations were taken from the *Millstone 3 FSAR, Table 11.2-4 (See column under Turbine Building).*

e. Each concentration above was multiplied by the total annual flow (9.95×10^9 cm^3, conservatively assuming 5 gpm continuous as discussed in item b).

f. The maximum individual organ dose is set equal to 1% of 75 mrem (40CFR190 limit). The limiting individual is the child; maximum organ is the thyroid. This value is approximately one quarter of the value requiring operation of the liquid treatment system as specified in *Section C.2* of the *Radiological Effluent Monitoring Manual.*

The setpoint corresponding to 0.75 mrem to the child's thyroid is 3.8×10^{-5} µCi/ml.

F. GASEOUS MONITOR SETPOINTS

F.1 Unit 1 Hydrogen Monitor

Per *Section 3.8.D.5* of the *Technical Specifications*, the alarm setpoint shall be less than or equal to 4% hydrogen by volume.

F.2 Unit 1 Steam Jet Air Ejector Offgas Monitor

Technical Specification 3.8.B.1 requires the alarm setpoint to be set up to ensure that the instantaneous noble gas release rate limits from the stack are not exceeded.

Technical Specification 3.8.D.6 specifies the maximum allowed noble gas in-process activity to be 1.47×10^6 µCi/sec. The value of 1.47×10^6 µCi/sec is based on an assumed release of the entire inventory in the off gas treatment system with 95% worst-case meteorology. At that level, the dose would still be less than 10CFR20 limits.

Based on *Section F.3 (below)*, the stack instantaneous release rate limit for MP-1 (assuming 1/3 of the site limit) is 363,000 µCi/sec. Assuming an approximate two factor decay from the air ejector monitor to the stack when using the 50 minute hold-up pipe, the corresponding activity at the air ejector is 700,000 µCi/sec and, hence, is more limiting than the 1.47×10^6 µCi/sec. When using the off gas treatment system, the decay factor is greater than 40, and hence, the 1.47×10^6 µCi/sec is more limiting.

The trip setpoint should be established by Station Chemistry to ensure Technical Specification Limits are met based on latest conversion factor from mR/hr to µCi/sec. Chemistry should specify the mR/hr corresponding to the following noble gas activity rates at the air ejector monitor:

With off gas treatment system out of service: $\leqq$ 700,000 µCi/sec
With all flow thru off gas treatment system: $\leqq$ 1,470,000 µCi/sec.

To avoid having to re-adjust the setpoint with a change in off gas treatment, it is recommended that the alarm correspond to $\leqq$ 700,000 µCi/sec unless a higher value is necessary to continue operations.

F.3 Unit 1 Stack Noble Gas Monitor

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

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Where:

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

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

Q_3 = Noble gas release rate from MP3 Vent (µCi/sec)

Assume 33% of the limit is from MP1 stack.

Therefore Q_1 should be less than 363,000 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 180,000 CFM.

Therefore, the alarm setpoint should be set at or below the "cps" corresponding to 363,000 µCi/sec from the calibration curve.

The alarm setpoint may be increased if the MP2 or MP3 vent setpoints are at levels corresponding to less than 33% of the site limit.

F.4 Unit 1 Main Stack Sampler Flow Rate Monitor

The MP1 mainstack 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 less than 2" Hg

or

b. Pressure Switch #1 greater than 18" Hg and Pressure Switch #2 less than 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:

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Assuming 33% of the limit is from the MP2 vent, the release rate limit for Unit 2 is 95,000 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 95,000 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 or MP3 vent setpoints are at levels corresponding to less than 33% of the site limit. Prior to decreasing the MP1 stack setpoint, evaluate if the MP1 steam jet air ejector setpoint needs to be changed to comply with *Technical Specification 3.8.B.1 (see Section F.2).*

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:

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Administratively all waste gas decay tank releases are via the MP1 stack. Assuming 33% of the limit is from the MP1 stack, the release rate limit for MP1 is 363,000 µCi/sec.

Releases from waste gas decay tanks are much lower than this limit and are based upon ventilation dilution, conservative meteorology ($X/Q = 10^{-3}$) and release flow rates to maintain offsite 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.

F.7 Unit 3 Vent Noble Gas Monitor

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

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Assuming 33% of the limit is from the MP3 vent, the release rate limit for Unit 3 is 95,000 µCi/sec. Based on the maximum ventilation flow rate of 210,000 CFM (per memo from G. C. Knight to R. A. Crandall, MP-3 - 1885, July 19, 1989) this converts to:

$$\begin{aligned} \text{Alarm setpoint} &= 95{,}000\ \mu\text{Ci/sec}/210{,}000\ \text{ft}^3\text{/min}/472 \\ &= 9.5 \times 10^{-4}\ \mu\text{Ci/cc} \end{aligned}$$

The alarm setpoint may be increased if the MP1 stack or MP2 vent setpoints are at levels corresponding to less than 33% of the site limit. Prior to decreasing the MP1 stack setpoint, evaluate if the MP1 steam jet air ejector setpoint needs to be changed to comply with *Technical Specification 3.8.B.1 (see Section F.2).*

F.8 Unit 3 Engineering Safeguards Building Monitor

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

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

Assuming releases less than 10% of the MP3 FSAR design releases of noble gases (*Table 11.3-11*, 1.4×10^4 Ci/year which is equal to 450 µCi/sec) assures that less than 1% of the above instantaneous release rate is added by this intermittent pathway (450/290,000 = 0.16%). Assuming a flow rate of 6,500 CFM (3.05×10^6 cc/sec) for this pathway translates this limit to:

$$0.1 \times 450/3.05 \times 10^6 = 1.5 \times 10^{-5}\ \mu\text{Ci/cc}$$

The Alarm setpoint should be set at or below this value.

APPENDIX A

DERIVATION OF FACTORS FOR SECTION C.1. - LIQUID DOSES

1. Section C.1.a - Step 3

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

$D_{QW(F)}$ = Calculated whole 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.

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

UNIT 1 - LIQUID - WHOLE BODY DOSES

Year	Quarter	C_F	$D_{QW(F)}$	$D_{QW(F)}$ / C_F (mrem/Ci)	C_H	$D_{QW(H)}$	$D_{QW(H)}$ / 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)	3.5 (-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)	4.0 (-7)
	2	0.049	5.2 (-4)	1.1 (-2)	1.29	2.9 (-7)	2.2 (-7)
	3	0.002	2.1 (-5)	1.1 (-2)	0.93		
	4	0.005	5.8 (-5)	1.2 (-2)	0.0002		
1979	1	0.045	4.4 (-4)	1.0 (-2)	1.78		
	2	0.146	1.5 (-3)	1.0 (-2)	2.83		
	3	0.009	9.7 (-5)	1.1 (-2)	0.94		
	4	0.010	4.6 (-5)	4.6 (-3)	2.37		
1980	1	0.013	6.2 (-5)	4.8 (-3)	2.40	3.04 (-7)	1.27 (-7)
	2	0.014	1.6 (-4)	1.1 (-2)	4.96	1.54 (-6)	3.10 (-7)
	3	0.011	1.2 (-4)	1.1 (-2)	6.45	1.67 (-6)	2.59 (-7)
	4	0.686	1.2 (-2)	1.8 (-2)	13.50		
1981	1	0.314	5.8 (-3)	1.9 (-2)	1.42		
	2	0.042	7.6 (-4)	1.8 (-2)	0.88		
	3	0.029	3.5 (-4)	1.2 (-2)	0.31		
	4	0.009	1.2 (-4)	1.3 (-2)	0.006		

UNIT 1 - LIQUID - WHOLE BODY DOSES *(Cont'd)*

Year	Quarter	C_F	$D_{QW(F)}$	$D_{QW(F)} / C_F$ (mrem/Ci)	C_H	$D_{QW(H)}$	$D_{QW(H)} / C_H$ (mrem/Ci)
1982	1	0.008	1.2 (-4)	1.5 (-2)	0.12		
	2	0.030	1.8 (-4)	6.0 (-3)	0.12		
	3	0.577	7.4 (-3)	1.3 (-2)	3.88		
	4	0.538	6.1 (-3)	1.1 (-2)	2.08		
1983	1	0.777	3.9 (-3)	5.0 (-3)	1.61		
	2	0.007	7.3 (-5)	1.0 (-2)	1.87	3.96 (-7)	2.12 (-7)
	3	0.007	1.0 (-4)	1.4 (-2)	3.64	1.16 (-6)	3.19 (-7)
	4	0.016	2.0 (-4)	1.3 (-2)	1.26		
1984	1	0.017	1.6 (-4)	9.4 (-3)	0.77		
	2	0.016	2.3 (-4)	1.4 (-2)	5.56	1.5 (-6)	2.7 (-7)
	3	0.003	3.1 (-5)	1.0 (-2)	1.06	1.5 (-7)	1.4 (-7)
	4	0.002	2.0 (-5)	1.0 (-2)	1.19	2.4 (-7)	2.0 (-7)
1985	1	0.038	4.5 (-4)	1.2 (-2)	2.61		
	2	0.025	3.3 (-4)	1.3 (-2)	2.43		
	3	0.354	3.1 (-3)	8.8 (-3)	5.26		
	4	0.049	6.7 (-4)	1.4 (-2)	7.56		
1986	1	0.019	2.2 (-4)	1.2 (-2)	1.73	4.9 (-7)	2.8 (-7)
	2	0.511	5.2 (-3)	1.0 (-2)	1.78	4.6 (-7)	2.6 (-7)
	3	0.239	2.2 (-3)	9.2 (-3)	1.01	2.4 (-7)	2.4 (-7)
	4	0.004	4.0 (-5)	1.0 (-2)	0.81	2.4 (-7)	3.0 (-7)
1987	1	0.012	1.1 (-4)	9.2 (-3)	1.65	4.0 (-7)	2.4 (-7)
	2	0.142	1.5 (-3)	1.1 (-2)	9.93	2.4 (-6)	2.4 (-7)
	3	0.413	6.6 (-3)	1.6 (-2)	2.66	6.6 (-7)	2.5 (-7)
	4	0.577	5.9 (-3)	1.0 (-2)	3.57	9.5 (-7)	2.7 (-7)
1988	1	0.598	6.2 (-3)	1.0 (-2)	2.88	8.3 (-7)	2.9 (-7)
	2	0.280	1.3 (-2)	4.6 (-2)	8.42	2.0 (-6)	2.4 (-7)
	3	0.145	7.5 (-3)	5.2 (-2)	11.8	2.6 (-6)	2.2 (-7)
	4	0.059	1.1 (-2)	1.9 (-1)	14.7	3.6 (-6)	2.4 (-7)
1989	1	0.087	1.1 (-2)	1.3 (-1)	11.4	3.0 (-6)	2.6 (-7)
	2	0.344	3.3 (-1)	9.6 (-1)	11.5	3.8 (-6)	3.3 (-7)
	3	0.353	2.8 (-1)	7.9 (-1)	3.86	8.8 (-7)	2.3 (-7)
	4	0.110	3.1 (-2)	2.8 (-1)	19.0	4.6 (-6)	2.4 (-7)

UNIT 2 - LIQUID - WHOLE BODY DOSES

Year	Quarter	C_F	$D_{QW(F)}$	$D_{QW(F)}/C_F$ (mrem/Ci)	C_H	$D_{QW(H)}$	$D_{QW(H)}/C_H$ (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)	2.9 (-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)	3.5 (-7)
	2	0.802	6.1 (-3)	7.6 (-3)	73.3	3.0 (-5)	4.1 (-7)
	3	0.037	1.6 (-4)	4.3 (-3)	42.1	1.5 (-5)	3.6 (-7)
	4	0.509	1.9 (-3)	3.7 (-3)	35.0	1.1 (-5)	3.1 (-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)	2.8 (-7)
	3	0.715	4.8 (-3)	6.7 (-3)	91.3	*	*
	4	0.372	1.8 (-3)	4.8 (-3)	72.0		
1979	1	1.65	9.6 (-3)	5.8 (-3)	64.6		
	2	2.48	2.8 (-2)	1.1 (-2)	27.8		
	3	0.331	2.8 (-3)	8.5 (-3)	68.4		
	4	0.411	3.0 (-3)	7.3 (-3)	93.0		
1980	1	0.635	4.0 (-3)	6.3 (-3)	97.7		
	2	0.285	1.7 (-3)	6.0 (-3)	57.0	1.09 (-5)	1.91 (-7)
	3	1.17	7.9 (-3)	6.8 (-3)	48.8		
	4	0.723	1.2 (-2)	1.7 (-2)	64.8	2.28 (-5)	3.52 (-7)
1981	1	0.435	6.8 (-3)	1.6 (-2)	55.3		
	2	0.343	5.8 (-3)	1.7 (-2)	149.0	5.41 (-5)	3.63 (-7)
	3	0.265	1.6 (-3)	6.0 (-3)	87.2	1.77 (-5)	2.03 (-7)
	4	3.14	1.0 (-2)	3.2 (-3)	79.9		
1982	1	1.65	1.0 (-2)	6.1 (-3)	7.4		
	2	9.94	8.4 (-3)	8.5 (-4)	88.3	4.91 (-5)	5.56 (-7)
	3	1.14	8.1 (-3)	7.1 (-3)	113.0		
	4	1.14	1.3 (-2)	1.1 (-2)	82.6		
1983	1	1.48	1.1 (-2)	7.4 (-3)	70.7		
	2	0.685	7.2 (-3)	1.1 (-2)	36.7		
	3	2.42	3.6 (-2)	1.5 (-2)	6.5		
	4	3.22	4.5 (-2)	1.4 (-2)	6.8		
1984	1	1.49	9.4 (-3)	6.3 (-3)	47.4		
	2	0.86	1.4 (-2)	1.6 (-2)	77.1	2.2 (-5)	2.9 (-7)
	3	0.41	3.9 (-3)	9.5 (-3)	136	2.6 (-5)	1.9 (-7)
	4	0.80	4.7 (-3)	5.9 (-3)	137	2.5 (-5)	1.8 (-7)
1985	1	1.17	8.4 (-3)	7.2 (-3)	34.9		
	2	2.29	3.0 (-2)	1.3 (-2)	5.7	1.5 (-6)	2.6 (-7)
	3	0.83	8.5 (-3)	1.0 (-2)	25.1	3.3 (-6)	1.3 (-7)
	4	0.30	4.9 (-3)	1.6 (-2)	100.0	2.9 (-5)	2.9 (-7)
1986	1	0.40	4.2 (-3)	1.1 (-2)	50.9	1.5 (-5)	2.9 (-7)
	2	0.36	4.0 (-3)	1.1 (-2)	134.0	3.5 (-5)	2.6 (-7)
	3	1.55	1.1 (-2)	7.1 (-3)	81.8	2.1 (-5)	2.6 (-7)
	4	2.18	1.1 (-2)	5.0 (-3)	12.9	3.8 (-6)	2.9 (-7)
1987	1	1.58	4.1 (-3)	2.6 (-3)	55.7	1.3 (-5)	2.3 (-7)
	2	1.08	5.7 (-3)	5.3 (-3)	53.7	1.3 (-5)	2.4 (-7)
	3	0.11	7.4 (-4)	6.7 (-3)	108	2.7 (-5)	2.5 (-7)
	4	1.30	9.8 (-3)	7.5 (-3)	68.6	1.8 (-5)	2.6 (-7)

* For data prior to 1986, tritium doses not listed when doses from tritium were less than 1/2% of the whole body doses.

UNIT 2 - LIQUID - WHOLE BODY DOSES (Cont'd)

Year	Quarter	C_F	$D_{QW(F)}$	$D_{QW(F)}$ / C_F (mrem/Ci)	C_H	$D_{QW(H)}$	$D_{QW(H)}$ / C_H (mrem/Ci)
1988	1	4.56	1.9 (-2)	4.2 (-3)	20.5	5.9 (-6)	2.9 (-7)
	2	2.84	1.2 (-2)	4.2 (-3)	96.4	2.3 (-5)	2.4 (-7)
	3	0.241	1.4 (-3)	5.8 (-3)	42.3	9.1 (-6)	2.2 (-7)
	4	1.25	1.1 (-2)	8.8 (-3)	99.9	2.4 (-5)	2.4 (-7)
1989	1	7.01	1.9 (-2)	2.7 (-3)	88.5	2.4 (-5)	2.7 (-7)
	2	3.07	1.9 (-2)	6.2 (-3)	21.4	7.0 (-6)	3.3 (-7)
	3	0.139	8.6 (-4)	6.2 (-3)	76.7	1.7 (-5)	2.2 (-7)
	4	0.448	3.1 (-3)	6.9 (-3)	179.	4.4 (-5)	2.5 (-7)

UNIT 3 - LIQUID - WHOLE BODY DOSES

Year	Quarter	C_F	$D_{QW(F)}$	$D_{QW(F)}/C_F$ (mrem/Ci)	C_H	$D_{QW(H)}$	$D_{QW(H)}/C_H$ (mrem/Ci)
1986	1	0.06	9.1 (-6)	1.5 (-4)	4.0	1.1 (-6)	2.8 (-7)
	2	0.88	2.5 (-4)	2.8 (-4)	99.6	2.6 (-5)	2.6 (-7)
	3	1.96	1.3 (-3)	6.6 (-4)	268	6.8 (-5)	2.5 (-7)
	4	0.11	2.7 (-4)	2.5 (-3)	169	5.0 (-5)	3.0 (-7)
1987	1	1.99	3.3 (-3)	1.7 (-3)	243	5.9 (-5)	2.4 (-7)
	2	1.76	3.4 (-3)	1.9 (-3)	171	4.2 (-5)	2.5 (-7)
	3	0.43	1.4 (-3)	3.3 (-3)	98.3	2.4 (-5)	2.4 (-7)
	4	1.22	1.4 (-2)	1.1 (-2)	77.4	2.1 (-5)	2.7 (-7)
1988	1	1.46	1.5 (-2)	1.0 (-2)	52.0	1.5 (-5)	2.9 (-7)
	2	0.72	3.3 (-3)	4.6 (-3)	124.	2.9 (-5)	2.3 (-7)
	3	0.30	1.5 (-3)	5.0 (-3)	95.1	2.1 (-5)	2.2 (-7)
	4	0.66	3.8 (-3)	5.8 (-3)	276.	6.7 (-5)	2.4 (-7)
1989	1	1.28	6.2 (-3)	4.8 (-3)	187.	4.9 (-5)	2.6 (-7)
	2	1.13	6.9 (-3)	6.1 (-3)	194.	6.3 (-5)	3.2 (-7)
	3	2.47	2.8 (-2)	1.1 (-2)	72.5	1.6 (-5)	2.2 (-7)
	4	1.05	1.3 (-2)	1.2 (-2)	244.	5.9 (-5)	2.4 (-7)

Projected Releases*	Ci/yr	Dose (mrem/year)	Dose/Ci
Total Fission and Activation (excl. H-3)	0.18	8.8 (-4)	4.9 (-3)
H-3	730	1.6 (-4)	2.2 (-7)

* From Unit 3 EROLS Table 5.2-4

Maximum Value of $D_{QW(F)}/C_F$ - Unit 1 = 9.6×10^{-1} mrem/Ci
Unit 2 = 1.7×10^{-2} mrem/Ci
Unit 3 = 1.2×10^{-2} mrem/Ci *(From 1986-1989 data)*

Average Value of $D_{QW(F)}/C_F$ - Unit 1 = 3.0×10^{-1} mrem/Ci *(From 1988-1989 data*)*
Unit 2 = 7.6×10^{-3} mrem/Ci
Unit 3 = 7.4×10^{-3} mrem/Ci *(From 1988-1989 data)*

Maximum Value of $D_{QW(H)}/C_H$ - Unit 1 = 4.3×10^{-7} mrem/Ci
Unit 2 = 5.6×10^{-7} mrem/Ci
Unit 3 = 3.2×10^{-7} mrem/Ci *(From 1986-1989 data)*

Average Value of $D_{QW(H)}/C_H$ - Unit 1 = 2.6×10^{-7} mrem/Ci
Unit 2 = 2.9×10^{-7} mrem/Ci
Unit 3 = 2.6×10^{-7} mrem/Ci *(From 1986-1989 data)*

The maximum value of $D_{QW(F)}/C_F$ is much higher for Unit 1 than for Units 2 and 3. This difference in dose/curie values was caused by the change in the isotopic mixture resulting from operation of the zinc injection system at Unit 1; therefore, a separate value for Unit 1 is necessary. The values for Units 2 and 3 are within a factor of 2 and can be conservatively applied to both units.

The maximum value for Unit 1 is less than 4 times the average value for the last 2 years. The maximum values for Units 2 and 3 are less than 3 times the average values for these units; therefore, these values are not over-conservative.

Since the maximum value $D_{QW(H)}/C_H$ is not much different for Units 1, 2 and 3, the same factor can be used for all three units (for simplicity). Also, the maximum values are less than three times the average values, indicating that the maximum value is not over-conservative.

* Dose factor values for Unit 1 have increased significantly because of the zinc injection process; therefore, only the last two years were averaged.

Thus, for Unit 1: $D_{QW(F)}/C_F = 1.0 \times 10^{0}$ mrem/Ci

$D_{QW(H)}/C_H = 5.6 \times 10^{-7}$ mrem/Ci

for Units 2 and 3: $D_{QW(F)}/C_F = 2.0 \times 10^{-2}$ mrem/Ci

$D_{QW(H)}/C_H = 5.6 \times 10^{-7}$ mrem/Ci

****Note:*** Although operation of Unit 3 increases the dilution flow, the near field dilution factor is reduced from 5 to 3. Therefore, the net effect is to reduce the doses by only a factor of 0.86. As can be seen in the 1986 - 1989 data, this has a negligible effect on the doses.

APPENDIX B

DERIVATION OF FACTORS FOR SECTION C.2. - LIQUID DOSES

1. **Section C.2.a - Step 2**

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 it is not included in the calculation.

UNIT 1 - LIQUID - DOSES - MAXIMUM ORGAN

Year	Quarter	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	Liver	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
	3	0.002	GI (LLI)	4.0 (-5)	0.02
	4	0.005	GI (LLI)	1.3 (-4)	0.026
1979	1	0.045	GI (LLI)	1.8 (-3)	0.04
	2	0.146	GI (LLI)	9.3 (-3)	0.064
	3	0.009	GI (LLI)	9.0 (-4)	0.10
	4	0.01	GI (LLI)	2.1 (-4)	0.021
1980	1	0.013	GI (LLI)	1.7 (-4)	0.013
	2	0.014	GI (LLI)	5.5 (-4)	0.039
	3	0.011	GI (LLI)	3.0 (-4)	0.027
	4	0.686	Liver	1.7 (-2)	0.025
1981	1	0.314	GI (LLI)	9.75 (-3)	0.031
	2	0.042	GI (LLI)	1.88 (-3)	0.045
	3	0.029	GI (LLI)	7.94 (-4)	0.027
	4	0.009	GI (LLI)	2.58 (-4)	0.029

UNIT 1 - LIQUID DOSES - Maximum Organ *(Cont'd)*

Year	Quarter	C_F	Max. Organ	D_{QO}	D_{QO}/C_F
1982	1	0.008	GI (LLI)	2.58 (-4)	0.032
	2	0.030	GI (LLI)	3.09 (-4)	0.010
	3	0.577	Liver	1.24 (-2)	0.021
			Thyroid	1.42 (-2)	0.025
	4	0.538	GI (LLI)	1.17 (-2)	0.022
1983	1	0.777	GI (LLI)	1.26 (-2)	0.016
	2	0.007	GI (LLI)	1.73 (-4)	0.025
	3	0.007	GI (LLI)	2.15 (-4)	0.031
	4	0.016	GI (LLI)	4.12 (-4)	0.026
1984	1	0.017	GI (LLI)	3.1 (-4)	1.8 (-2)
	2	0.016	GI (LLI)	6.0 (-4)	3.8 (-2)
	3	0.003	GI (LLI)	6.1 (-5)	2.0 (-2)
	4	0.002	GI (LLI)	3.7 (-5)	1.9 (-2)
1985	1	0.038	GI (LLI)	7.7 (-4)	2.0 (-2)
	2	0.025	GI (LLI)	5.1 (-4)	2.0 (-2)
	3	0.354	Liver	5.4 (-3)	1.5 (-2)
	4	0.049	Liver	1.0 (-3)	2.0 (-2)
1986	1	0.019	GI (LLI)	1.1 (-3)	5.8 (-2)
	2	0.511	Liver	7.2 (-3)	1.4 (-2)
	3	0.239	Liver	3.0 (-3)	1.3 (-2)
	4	0.004	Bone	1.5 (-4)	3.8 (-2)
1987	1	0.012	Bone	1.6 (-4)	1.3 (-2)
	2	0.142	GI (LLI)	3.0 (-3)	2.1 (-2)
	3	0.413	GI (LLI)	1.2 (-2)	2.9 (-2)
	4	0.577	GI (LLI)	2.0 (-2)	3.5 (-2)
1988	1	0.598	GI (LLI)	2.4 (-2)	3.9 (-2)
	2	0.280	Liver	2.7 (-2)	9.6 (-2)
	3	0.145	Liver	1.6 (-2)	1.1 (-1)
	4	0.059	Liver	2.4 (-2)	4.1 (-1)
1989	1	0.087	Liver	2.3 (-2)	2.6 (-1)
	2	0.344	Liver	7.3 (-1)	2.1 (0)
	3	0.353	Liver	6.2 (-1)	1.8 (0)
	4	0.110	Liver	6.9 (-2)	6.3 (-1)

UNIT 2 - LIQUID DOSES - MAXIMUM ORGAN

Year	Quarter	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	0.102
	3	0.715	GI (LLI)	4.2 (-2)	0.059
	4	0.372	GI (LLI)	9.0 (-3)	0.024
1979	1	1.65	GI (LLI)	4.1 (-2)	0.025
	2	2.48	GI (LLI)	2.4 (-1)	0.097
	3	0.331	GI (LLI)	1.8 (-2)	0.054
	4	0.411	GI (LLI)	1.6 (-2)	0.039
1980	1	0.635	GI (LLI)	1.1 (-2)	0.017
	2	0.285	GI (LLI)	3.9 (-3)	0.014
	3	1.17	GI (LLI)	1.0 (-1)	0.085
	4	0.723	GI (LLI)	7.4 (-2)	0.102
1981	1	0.435	GI (LLI)	2.91 (-2)	0.067
	2	0.343	GI (LLI)	2.91 (-2)	0.085
	3	0.265	GI (LLI)	7.47 (-3)	0.028
	4	3.14	Liver	1.67 (-2)	0.005
1982	1	1.65	GI (LLI)	9.6 (-2)	0.058
	2	9.94	GI (LLI)	5.76 (-2)	0.006
			Thyroid	3.59 (-1)	0.036
	3	1.14	GI (LLI)	2.43 (-2)	0.021
			Thyroid	2.84 (-2)	0.025
	4	1.14	Liver	1.09 (-2)	0.010
1983	1	1.48	Liver	1.66 (-2)	0.011
	2	0.685	Liver	1.14 (-2)	0.017
	3	2.42	GI (LLI)	6.36 (-2)	0.026
	4	3.22	GI (LLI)	7.74 (-2)	0.024
1984	1	1.49	GI (LLI)	1.7 (-2)	1.1 (-2)
	2	0.86	GI (LLI)	2.3 (-2)	2.7 (-2)
	3	0.41	Liver	6.1 (-3)	1.5 (-2)
	4	0.80	Thyroid	1.6 (-2)	2.0 (-2)
1985	1	1.17	Thyroid	2.5 (-2)	2.1 (-2)
	2	2.29	GI (LLI)	8.0 (-2)	3.5 (-2)
	3	0.83	GI (LLI)	4.3 (-2)	5.2 (-2)
	4	0.30	GI (LLI)	2.5 (-2)	8.3 (-2)
1986	1	0.40	GI (LLI)	1.5 (-2)	3.8 (-2)
	2	0.36	GI (LLI)	6.6 (-3)	1.8 (-2)
	3	1.55	GI (LLI)	4.1 (-2)	2.6 (-2)
	4	2.18	GI (LLI)	1.1 (-1)	5.0 (-2)
1987	1	1.58	GI (LLI)	2.9 (-2)	1.8 (-2)
	2	1.08	GI (LLI)	2.1 (-2)	1.9 (-2)
	3	0.11	GI (LLI)	3.8 (-3)	3.5 (-2)
	4	1.30	GI (LLI)	5.4 (-2)	4.2 (-2)

UNIT 2 - LIQUID DOSES - MAXIMUM ORGAN (Cont'd)

Year	Quarter	C_F	Max. Organ	D_{QO}	D_{QO}/C_F
1988	1	4.56	GI (LLI)	9.9 (-2)	2.2 (-2)
	2	2.84	GI (LLI)	9.7 (-2)	3.4 (-2)
	3	0.241	GI (LLI)	8.3 (-3)	3.4 (-2)
	4	1.25	GI (LLI)	5.2 (-2)	4.2 (-2)
1989	1	7.01	GI (LLI)	1.3 (-1)	1.9 (-2)
	2	3.07	GI (LLI)	3.6 (-1)	1.2 (-1)
	3	0.139	GI (LLI)	1.6 (-2)	1.2 (-1)
	4	0.448	GI (LLI)	4.6 (-2)	1.0 (-1)

UNIT 3 - LIQUID DOSES - MAXIMUM ORGAN

Year	Quarter	C_F	Max. Organ	D_{QO}	D_{QO}/C_F
1986	1	0.06	GI(LLI)	4.6 (-5)	7.7 (-4)
	2	0.88	GI(LLI)	3.1 (-3)	3.5 (-3)
	3	1.96	GI(LLI)	2.2 (-2)	1.1 (-2)
	4	0.11	GI(LLI)	1.2 (-2)	1.1 (-1)
1987	1	1.99	GI(LLI)	3.7 (-2)	1.9 (-2)
	2	1.76	GI(LLI)	4.2 (-2)	2.4 (-2)
	3	0.43	GI(LLI)	7.9 (-3)	1.8 (-2)
	4	1.22	GI(LLI)	6.9 (-2)	5.7 (-2)
1988	1	1.46	GI(LLI)	1.1 (-1)	7.5 (-2)
	2	0.72	GI(LLI)	3.6 (-2)	5.0 (-2)
	3	0.30	GI(LLI)	7.3 (-3)	2.4 (-2)
	4	0.66	GI(LLI)	3.2 (-2)	4.8 (-2)
1989	1	1.28	GI(LLI)	7.1 (-2)	5.5 (-2)
	2	1.13	GI(LLI)	3.5 (-2)	3.1 (-2)
	3	2.47	GI(LLI)	3.0 (-1)	1.2 (-1)
	4	1.05	GI(LLI)	1.5 (-1)	1.4 (-1)

Projected Releases From ER Ci/yr	Max. Organ	Dose (mrem/year)	Dose/Ci
0.18	Thyroid	6.3 (-3)	0.035

Maximum Value of D_{QO}/C_F - Unit 1 - 2.1 mrem/Ci
Unit 2 - 0.12 mrem/Ci
Unit 3 - 0.14 mrem/Ci *(From 1986-1989 data)*

Average Value of D_{QO}/C_F - Unit 1 - 0.68 mrem/Ci *(From 1988-1989 data*)*
Unit 2 - 0.043 mrem/Ci
Unit 3 - 0.068 mrem/Ci *(From 1988-1989 data)*

The maximum value of $D_{QO(F)}/C_F$ is much higher for Unit 1 than for Units 2 and 3. This difference in dose/curie values was caused by the change in isotopic mixture resulting from operation of the zinc injection system at Unit 1; therefore, a separate value for Unit 1 is necessary. The values for Units 2 and 3 are within a factor of 2 and can be conservatively applied to both units.

The maximum value for all three units is less than three times the average values; therefore, this is not over-conserviative.

Thus, for Unit 1: $D_{QO(F)}/C_F = 2.1$

for Units 2 and 3: $D_{QO(F)}/C_F = 0.2$

* Dose factor values for Unit 1 have increased significantly because of the change in isotopic mixture caused by the zinc injection process; therefore, only the last two years were averaged.

APPENDIX C

LIQUID DOSE CALCULATIONS - LADTAP

The LADTAP code was written by the NRC to compute doses from liquid releases. The actual model used is LADTAP II which performs calculations in accordance with *Regulatory Guide 1.109, Revision 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 *(Final Environmental Statements for MP1 and 2)*
4. Shorewidth factor = 0.5 *(Table A-9, Regulatory Guide 1.109)*
5. Dilution for maximum individual pathways = 3 *(Page 5.2-5 of MP3 Environmental Report)*
6. Thirty-minute Discharge Transit Time - time to transit quarry; estimated from chloride study *(MP3 Environmental Report)*
7. *Regulatory Guide 1.109* usage factors for maximum 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	Land Maximum X/Q	Residence Maximum D/Q	Cow or Goat Maximum D/Q
1980	1	5.3 (-8)	----------*	----------**
	2	4.0 (-8)	1.7 (-9)	3.6 (-10)
	3	5.6 (-8)	1.8 (-9)	2.7 (-10)
	4	6.3 (-8)	4.0 (-9)	1.4 (-9)
1981	1	4.5 (-8)	----------	----------
	2	3.9 (-8)	9.1 (-10)	1.7 (-10)
	3	6.3 (-8)	1.6 (-9)	6.2 (-10)
	4	5.6 (-8)	5.9 (-9)	7.1 (-10)
1982	1	5.9 (-8)	----------	----------
	2	3.8 (-8)	2.4 (-9)	4.4 (-10)
	3	4.8 (-8)	2.2 (-9)	7.2 (-10)
	4	5.1 (-8)	3.2 (-9)	9.8 (-10)
1983	1	3.7 (-8)	----------	----------
	2	6.0 (-8)	1.3 (-9)	3.8 (-10)
	3	4.4 (-8)	1.8 (-9)	5.4 (-10)
	4	6.0 (-8)	5.4 (-9)	1.2 (-9)
1984	1	4.8 (-8)	----------	----------
	2	5.4 (-8)	6.8 (-10)	4.7 (-10)
	3	5.0 (-8)	1.7 (-9)	5.3 (-10)
	4	5.3 (-8)	3.4 (-9)	1.0 (-9)
1985	1	4.8 (-8)	----------	----------
	2	4.5 (-8)	2.3 (-9)	3.0 (-10)
	3	6.1 (-8)	1.5 (-9)	5.6 (-10)
	4	5.6 (-8)	4.7 (-9)	1.1 (-9)
1986	1	5.0 (-8)	----------	----------
	2	4.9 (-8)	2.3 (-9)	2.4 (-10)
	3	5.8 (-8)	2.4 (-9)	6.3 (-10)
	4	6.3 (-8)	5.0 (-9)	1.2 (-9)
1987	1	4.3 (-8)	----------	----------
	2	3.4 (-8)	1.2 (-9)	3.4 (-10)
	3	5.8 (-8)	1.6 (-9)	5.9 (-10)
	4	5.0 (-8)	5.9 (-9)	8.9 (-10)

* Not listed since fruits and vegetables are only harvested during the second and third quarters, fourth quarter listed in case milk animals are at maximum residence.

** Not listed since milk animals are not on pasture during the first quarter.

Highest Land Maximum X/Q	=	6.3×10^{-8} sec/m^3
Highest Residence Maximum D/Q	=	5.9×10^{-9} m^{-2}
Highest Milk Animal D/Q	=	1.4×10^{-9} m^{-2}
Average Land Maximum X/Q	=	5.1×10^{-8}
Average Residence Maximum D/Q	=	2.7×10^{-9}
Average Milk Animal Maximum D/Q	=	6.5×10^{-10}

Unit 2 - Vents

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

Year/Qtr.	Land Maximum X/Q Continuous	Land Maximum X/Q Batch	Residence Maximum D/Q Continuous	Residence Maximum D/Q Batch	Cow or Goat Maximum D/Q Continuous	Cow or Goat Maximum D/Q Batch
1980 - 1	2.3 (-6)	9.5 (-7)	---------	---------	---------	---------
2	6.9 (-6)	6.8 (-6)	1.1 (-7)	1.3 (-7)	3.8 (-9)	4.1 (-9)
3	7.3 (-6)	3.4 (-8)	1.2 (-7)	3.3 (-9)	4.9 (-9)	1.7 (-10)
4	3.2 (-6)	7.5 (-7)	7.6 (-8)	8.2 (-9)	2.7 (-9)	3.0 (-9)
1981 - 1	3.9 (-6)	1.3 (-7)	---------	---------	---------	---------
2	7.9 (-6)	1.9 (-7)	1.0 (-7)	7.0 (-10)	3.6 (-9)	1.6 (-10)
3	4.9 (-6)	1.4 (-7)	9.6 (-8)	4.9 (-9)	3.7 (-9)	7.7 (-10)
4	1.7 (-6)	6.2 (-8)	4.1 (-8)	5.1 (-9)	1.8 (-9)	9.4 (-10)
1982 - 1	2.9 (-6)	2.4 (-7)	---------	---------	---------	---------
2	6.5 (-6)	9.3 (-8)	9.2 (-8)	---------	3.4 (-9)	---------
3	6.7 (-6)	1.4 (-7)	1.2 (-7)	2.1 (-9)	4.8 (-9)	9.3 (-10
4	4.2 (-6)	1.8 (-7)	1.0 (-7)	2.6 (-9)	2.9 (-9)	9.3 (-10
1983 - 1	1.3 (-6)	1.0 (-7)	---------	---------	---------	---------
2	5.4 (-6)	1.9 (-7)	1.1 (-7)	5.2 (-9)	5.5 (-9)	2.0 (-9)
3	8.1 (-6)	2.4 (-7)	1.5 (-7)	4.4 (-9)	5.4 (-9)	1.5 (-9)
4	2.3 (-6)	1.2 (-7)	6.2 (-8)	8.4 (-9)	3.3 (-9)	---------
1984 - 1	2.3 (-6)	1.1 (-7)	---------	---------	---------	---------
2	5.4 (-6)	3.4 (-7)	8.0 (-8)	4.2 (-9)	4.4 (-9)	1.5 (-9)
3	7.2 (-6)	1.5 (-7)	1.4 (-7)	5.4 (-9)	6.1 (-9)	6.2 (-10
4	2.8 (-6)	8.3 (-8)	9.4 (-8)	5.6 (-9)	3.3 (-9)	2.0 (-9)
1985 - 1	4.0 (-6)	1.3 (-7)	---------	---------	---------	---------
2	7.6 (-6)	3.4 (-7)	1.3 (-7)	9.0 (-9)	4.8 (-9)	2.4 (-9)
3	7.8 (-6)	1.3 (-7)	1.3 (-7)	3.4 (-9)	5.4 (-9)	7.1 (-10
4	3.8 (-6)	2.1 (-7)	9.5 (-8)	4.8 (-8)	2.5 (-9)	1.6 (-9)
1986 - 1	4.0 (-6)	ND	---------	---------	---------	---------
2	5.5 (-6)	3.6 (-7)	9.7 (-8)	0	3.5 (-9)	0
3	5.5 (-6)	1.6 (-7)	1.5 (-7)	1.4 (-8)	4.4 (-9)	9.2 (-10
4	3.0 (-6)	1.9 (-7)	8.8 (-8)	2.6 (-8)	2.9 (-9)	5.5 (-9)
1987 - 1	1.9 (-6)	1.4 (-7)	---------	---------	---------	---------
2	6.8 (-6)	5.6 (-8)	9.7 (-8)	1.7 (-9)	5.0 (-9)	3.1 (-10
3	4.8 (-6)	---------	1.1 (-7)	---------	3.3 (-9)	---------
4	4.1 (-6)	1.3 (-7)	9.8 (-8)	5.2 (-9)	3.1 (-9)	3.3 (-9)

Average Maximum Quarterly x/Q - Continuous Release = 4.8 x 10^{-6}
Maximum Quarterly x/Q - Continuous Release = 8.1 x 10^{-6}

Average Maximum Quarterly x/Q - Batch Release = 4.3 x 10^{-7}
Maximum Quarterly x/Q - Batch Release = 6.8 x 10^{-6}

Average Maximum Quarterly D/Q - Residence - Continuous Release = 1.0 x 10^{-7}
Maximum Quarterly D/Q - Residence - Continuous Release = 1.5 x 10^{-7}

Average Maximum Quarterly D/Q - Residence - Batch Release = 1.4×10^{-8}
Maximum Quarterly D/Q - Residence - Batch Release = 1.3×10^{-7}

Average Maximum Quarterly D/Q - Milk Animal - Continuous Release = 3.9×10^{-9}
Maximum Quarterly D/Q - Milk Animal - Continuous Release = 6.1×10^{-9}

Average Maximum Quarterly D/Q - Milk Animal - Batch Release = 1.6×10^{-9}
Maximum Quarterly D/Q - Milk Animal - Batch Release = 5.5×10^{-9}

Beginning in 1982, purges are released through the Unit 1 stack. Therefore, the batch releases should have lower X/Q's and D/Q's.

This is shown in the above data, however, at much lesser extent in the maximum values versus the average values.

Unit 3 - Vents

	Land Maximum X/Q		Residence Maximum D/Q		Cow or Goat Maximum D/Q	
Year/Qtr.	**Continuous**	**Batch**	**Continuous**	**Batch**	**Continuous**	**Batch**
1986 - 1	1.7 (-6)	1.4 (-6)	---------	---------	---------	---------
2	2.2 (-6)	7.8 (-6)	8.4 (-8)	5.1 (-7)	3.3 (-9)	2.1 (-9)
3	1.7 (-6)	1.2 (-5)	8.6 (-8)	2.5 (-7)	4.2 (-9)	2.8 (-8)
4	1.3 (-6)	---------	7.2 (-8)	---------	2.8 (-9)	---------
1987 - 1	1.7 (-6)	2.1 (-6)	---------		---------	
2	6.5 (-6)		1.3 (-7)		4.9 (-9)	
3	3.3 (-6)		8.0 (-8)		3.1 (-9)	
4	2.4 (-6)		7.9 (-8)		3.1 (-9)	

Average Maximum Quarterly X/Q - Continuous Release = 2.6×10^{-6}
Maximum Quarterly X/Q - Continuous Release = 6.5×10^{-6}

Average Maximum Quarterly X/Q - Batch Release = 5.8×10^{-6}
Maximum Quarterly X/Q - Batch Release = 1.2×10^{-5}

Average Maximum Quarterly D/Q - Residence - Continuous Release = 8.9×10^{-8}
Maximum Quarterly D/Q - Residence - Continuous Release = 1.3×10^{-7}

Average Maximum Quarterly D/Q - Residence - Batch Release = 3.8×10^{-7}
Maximum Quarterly D/Q-Residence-Batch Release = 5.1×10^{-7}

Average Maximum Quarterly D/Q - Milk Animal - Continuous Release = 3.6×10^{-9}
Maximum Quarterly D/Q - Residence - Continuous Release = 4.9×10^{-9}

Average Maximum Quarterly D/Q - Milk Animal - Batch Release = 1.5×10^{-8}
Maximum Quarterly D/Q - Milk Animal - Batch Release = 2.8×10^{-8}

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

Unit 1 Stack Gaseous Releases - Curies *vs.* Dose

Year	Quarter	Avg. Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) 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	9.5 (-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	0.044	0.044	1.3 (-4)
	4	530	0.034	0.034	6.5 (-5)
	1-4	18,100	7.6	7.6	4.2 (-4)
1979	1	1,180	0.032	0.032	2.7 (-5)
	2	380	0.024	0.024	6.3 (-5)
	3	640	0.061	0.061	9.5 (-5)
	4	420	0.024	0.024	5.7 (-5)
	1-4	655	0.14	0.14	2.1 (-4)
1980	1	360	0.018	0.020	5.0 (-5)
	2	230	0.019	0.019	8.2 (-5)
	3	880	0.20	0.20	2.3 (-4)
	4	40	6.4 (-4)	6.4 (-4)	1.6 (-5)
	1-4	380	0.24	0.24	6.3 (-4)
1981	1	1.2	6.0 (-6)	6.0 (-6)	5.0 (-6)
	2	25	0.004	0.004	1.6 (-4)
	3	1,580	0.19	0.19	1.2 (-4)
	4	220	0.015	0.016	6.8 (-5)
	1-4	460	0.21	0.21	4.6 (-4)
1982	1	160	0.004	0.004	2.5 (-5)
	2	140	0.042	0.042	3.0 (-4)
	3	490	0.051	0.052	1.0 (-4)
	4	240	0.002	0.002	8.3 (-6)
	1-4	260	0.10	0.10	3.8 (-4)
1983	1	560	0.002	0.002	3.6 (-6)
	2	120	0.014	0.014	1.2 (-4)
	3	74	0.012	0.012	1.6 (-4)
	4	56	0.003	0.003	5.4 (-5)
	1-4	200	0.031	0.031	1.6 (-4)

Unit 1 Stack Gaseous Releases - Curies *vs.* Dose (Cont'd)

Year	Quarter	Avg. Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) Skin	mrem per µCi/Sec W.B. and Skin
1984	1	119	0.0091	0.0091	7.6 (-5)
	2	352	0.0029	0.0029	8.2 (-6)
	3	197	0.037	0.037	1.9 (-4)
	4	46	0.0002	0.0002	4.8 (-6)
	1-4	179	0.049	0.049	2.7 (-4)
1985	1	86	0.010	0.013	1.2 (-4)
	2	33	0.0058	0.0058	1.8 (-4)
	3	9.5	0.0004	0.0004	4.2 (-5)
	4	14	0.0009	0.0009	6.4 (-5)
	1-4	35.6	0.017	0.020	4.8 (-4)
1986	1	7.6	0.0028	0.0034	3.7 (-4)
	2	84	0.021	0.021	2.5 (-4)
	3	199	0.046	0.046	2.3 (-4)
	4	131	0.015	0.018	1.1 (-4)
	1-4	105	0.085	0.088	8.1 (-4)
1987	1	419	0.037	0.041	8.8 (-5)
	2	285	0.043	0.043	1.5 (-4)
	3	21	0.0022	0.0028	1.0 (-4)
	4	19	9.7 (-4)	0.0014	5.1 (-5)
	1-4	186	0.083	0.088	4.5 (-4)

Unit 2 Vent Gaseous Releases - Curies *vs.* Dose*

Year	Quarter	Avg. Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) 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
1979	1	7.1**	0.0081	0.019	1.1 (-3)	2.3
	2	2.6	0.0007	0.0021	2.5 (-4)	3.2
	3	38	0.013	0.037	3.4 (-4)	2.8
	4	23	0.0052	0.015	2.3 (-4)	2.9
	1-4	18	0.027	0.073	1.5 (-3)	2.7

Unit 2 Vent Gaseous Releases - Curies *vs.* Dose (Cont'd)

Year	Quarter	Avg. Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) Skin	mrem per µCi/Sec W.B.	Ratio Skin/W.B.
1980	1	54	0.0086	0.022	1.6 (-4)	2.6
	2	47	0.020	0.056	4.3 (-4)	2.8
	3	67	0.066	0.13	9.9 (-4)	2.0
	4	2.5	0.0028	0.0043	1.1 (-3)	1.5
	1-4	42	0.097	0.212	2.3 (-3)	2.2
1981	1	16	0.0061	0.014	3.8 (-4)	2.3
	2	124	0.075	0.20	6.0 (-4)	2.7
	3	64	0.030	0.078	4.7 (-4)	2.6
	4	79	0.013	0.033	1.6 (-4)	2.5
	1-4	71	0.124	0.325	1.7 (-3)	2.6
1982	1	5.3***	0.013	0.022	2.5 (-3)	1.7
	2	322	0.18	0.49	5.6 (-4)	2.7
	3	205	0.13	0.34	6.3 (-4)	2.6
	4	191	0.074	0.18	3.9 (-4)	2.4
	1-4	180	0.397	1.03	2.2 (-3)	2.6
1983	1	464	0.041	0.11	8.8 (-5)	2.7
	2	659	0.22	0.62	3.3 (-4)	2.8
	3	0	0.0045	0.0053	---------	1.2
	4	0	0.0020	0.0023	---------	1.2
	1-4	280	0.268	0.737	9.6 (-4)	2.8
1984	1	320	0.046	0.13	1.4 (-4)	2.8
	2	68	0.018	0.048	2.6 (-4)	2.7
	3	111	0.044	0.12	4.0 (-4)	2.7
	4	42	0.014	0.041	3.3 (-4)	2.9
	1-4	135	0.12	0.34	9.0 (-4)	2.8
1985	1	45	0.020	0.038	4.4 (-4)	1.9
	2	1.0	0.0012	0.0014	1.2 (-3)	1.2
	3	3.1	0.0051	0.012	1.6 (-3)	2.4
	4	2.6	0.0027	0.0048	1.1 (-3)	1.8
	1-4	12.9	0.029	0.056	2.2 (-3)	1.9
1986	1	2.7	0.0020	0.0048	7.4 (-4)	2.4
	2	1.6	0.0019	0.0039	1.2 (-3)	2.1
	3	8.6	0.0055	0.012	6.4 (-4)	2.2
	4	0.03	7.7 (-4)	9.1 (-4)	2.6 (-2)†	1.2
	1-4	3.2	0.010	0.022	3.2 (-3)	2.2
1987	1	16	0.0018	0.0051	1.1 (-4)	2.8
	2	5.6	0.0031	0.0084	5.5 (-4)	2.7
	3	17	0.0053	0.015	3.1 (-4)	2.8
	4	12	0.0029	0.0078	2.4 (-4)	2.7
	1-4	12.7	0.013	0.036	1.0 (-3)	2.8

* Dose conservatively assumes contributions from both plume and ground shine.

** Only continuous ventilation (purge data leads to an unconservative value).

*** Beginning in 1982, purges are released through Unit 1 stack.

† Outlier caused by low noble gas releases. At such low releases, the doses are well below the limits.

Unit 3 Vent

Gaseous Releases - Curies *vs.* Dose

Year	Quarter	Avg. Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) Skin	mrem per µCi/Sec W.B.	Ratio Skin/W.B.
1986	1	0.038	3.7 (-5)	8.7 (-5)	9.7 (-4)	2.4
	2	-------	5.9 (-5)	1.7 (-4)	---------	2.9
	3	2.1	3.4 (-4)	7.1 (-4)	1.6 (-4)	2.1
	4	0.81	8.3 (-5)	2.3 (-4)	1.0 (-4)	2.8
	1-4	0.74	5.2 (-4)	1.2 (-3)	7.0 (-4)	2.3
1987	1	0.94	6.3 (-4)	8.7 (-4)	6.7 (-4)	1.4
	2	6.6	2.3 (-3)	6.4 (-3)	3.5 (-4)	2.8
	3	0.002	1.4 (-6)	2.2 (-6)	7.0 (-4)	1.6
	4	6.3	1.4 (-2)	1.8 (-2)	2.2 (-3)	1.3
	1-4	3.5	1.7 (-2)	2.5 (-2)	4.8 (-3)	1.5

Release Projection	Noble Gas Release Rate (µCi/Sec)	Max. Individual Dose (mrem) W.B.	Max. Individual Dose (mrem) Skin	mrem per µCi/Sec W.B.	Ratio Skin/W.B.
Unit 3 FSAR* and ER	14.2	0.16	0.29	1.1 (-2)	1.8

* Expected releases from *Table 11.3-11*: 448 Ci/yr which equals 14.2 µCi/sec.

Design releases from Unit 3 *FSAR Table 11.3-11* and Unit 3 *ER Table 3.5-14: 14, 141* Ci/yr. = 448 µCi/sec.

Since the average X/Q's are less for Unit 3 than for Unit 2, a conservative estimate for Unit 3 would be to assume its value would be the same as for Unit 2. The 1976-1987 average values for whole body doses are:

Unit 1 = 4.5×10^{-4} mrem/yr. per µCi/sec

Unit 2 = 1.7×10^{-3} mrem/yr. per µCi/sec

Unit 3 = 1.7×10^{-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, Unit 2, or Unit 3 releases, we can use the 500 mrem as the limiting dose. Therefore, the release rate limits would be:

Unit 1: $500/4.5 \times 10^{-4} = 1{,}100{,}000$

Unit 2: $500/1.7 \times 10^{-3} = 290{,}000$

Unit 3: $500/1.7 \times 10^{-3} = 290{,}000$

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

$$\frac{Q_1}{1{,}100{,}000} + \frac{Q_2}{290{,}000} + \frac{Q_3}{290{,}000} \leq 1$$

where:

Q_1 = noble gas release rate from MP1 stack (µCi/sec)
Q_2 = noble gas release rate from MP2 vent (µCi/sec)
Q_3 = noble gas release rate from MP3 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 *Regulatory 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 and Unit 3 were calculated using the NRC GASPAR code which uses the methodology of *Regulatory Guide 1.109*.

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

Unit 1:	Minimum Value	-	3.6×10^{-6} mrem/qtr. per µCi/sec
	Average Value	-	1.1×10^{-4} mrem/qtr. per µCi/sec
	Maximum Value	-	3.7×10^{-4} mrem/qtr. per µCi/sec
Unit 2:	Minimum Value	-	8.8×10^{-5} mrem/qtr. per µCi/sec
	Average Value	-	5.3×10^{-4} mrem/qtr. per µCi/sec
	Maximum Value	-	2.5×10^{-3} mrem/qtr. per µCi/sec

It can be seen that the maximum value observed is only a factor of 5 greater than the average value even though there have been significant changes in the isotopic compositions of the releases and/or the meteorological frequencies. Also note that the maximum annual average is less than a factor of 2 greater than the average of the annual averages.

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. Period 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. Although *10CFR20.106* allows averaging concentrations of radioactive material over a period not greater than one year, this does not suggest that the worst-case year should be used for release rate determinations. *NUREG-0133* recommends that the STS consider historical annual average atmospheric dispersion conditions. Therefore, average values from above are adequate for release rate calculations. This is conservative since the maximum quarterly averages are not typically at the same location.

4. It should also be recognized that there is 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.

   c. *10CFR20* states that these limits are for noble gases only. However, we have included the ground shine dose from particulates.

5. It must also be recognized that the type of empirical method given above is a 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 release 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
   MP3 ventilation from radiological areas
   MP3 condenser air ejector
   MP3 reactor plant gaseous vents
   MP3 radioactive gaseous waste system
   MP3 containment vacuum pump
   MP3 reactor plant aërated vents
   MP3 steam generator blowdown tank vent

   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 recalculations and monitor setpoint 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. Therefore, a practical solution is to use a conservatively determined empirical method as given above.

3. **Section D.1.b - Release Rate Limit - Iodine and Particulates**

Doses are calculated using the methods of *NUREG-0133* dated October 1978 and *NRC Regulatory Guide 1.109, Revision 1*. Note that the equation of *page 27* of *NUREG-0133* (for all radionuclides, except tritium) has been corrected for the elemental iodine fraction, as in *Regulatory Guide 1.109, Revision 1*. Since the doses are dependent on the season, (i.e., milk animals on pasture, harvest season), and the exact locations of milking animals, use three methods when performing these calculations.

Method 1

Assume milk animals are on pasture, vegetation is being harvested, and milk animals are at maximum land D/Q location.

Method 2

Assume annual average X/Q and D/Q as above, however:

i. If 1st quarter, neglect vegetation and milk doses.

ii. If 4th quarter, neglect vegetation doses.

iii. For batch releases (including weekly continuous releases, if necessary), if it can be verified that milk animals are not on pasture and/or vegetation is not being harvested, these may be neglected.

Method 3

Review existing cow and goat locations. Determine if the average of the maximum quarterly D/Q data from *Appendix D.1* is acceptable to use (i.e., no milk animal likely to be more critical than the data for 1983-1987). If acceptable, use the calculated average D/Q. If not, determine an acceptable D/Q by averaging at least 10 quarters of meteorological data.

Dose formula for iodine is:

$$D_{T_I} = \underbrace{\left[X/Q \cdot P_i \cdot Q_I \right]}_{\text{Inhalation}} + \underbrace{\left[D/Q \cdot P_i \cdot Q_I \right]}_{\text{Vegetation}} + \underbrace{\left[D/Q \cdot P_i \cdot Q_I \right]}_{\text{Milk}}$$

where: D_{T_I} = thyroid dose rate from iodine releases

Q_I = release rate of iodine, µCi/sec

X/Q = meteorological dispersion factor, sec/m^3

D/Q = deposition factor, m^{-2}

P_i = values derived from *NUREG-0133* and *Regulatory Guide 1.109 (see Table 1)*.

Dose formula for tritium is:

$$D_{T_H} = \underbrace{\left[X/Q \cdot P_i \cdot Q_H \right]}_{\text{Inhalation}} + \underbrace{\left[X/Q \cdot P_i \cdot Q_H \right]}_{\text{Vegetation}} + \underbrace{\left[X/Q \cdot P_i \cdot Q_H \right]}_{\text{Milk}}$$

where: D_{T_H} = thyroid (or any other organ) dose rate from tritium releases

Q_H = release rate of H-3, µCi/sec

other parameters as described above, except units for P_i. Since milk and vegetable doses from tritium are related to X/Q and not D/Q, use the units for inhalation (see *NUREG-0133* and/or *Regulatory Guide 1.109, Revision 1* for details).

Dose formula for particulates is:

$$D_{O_P} = \underbrace{\left[X/Q \cdot P_i \cdot Q_P\right]}_{\text{Inhalation}} + \underbrace{\left[D/Q \cdot P_i \cdot Q_P\right]}_{\text{Vegetation}} + \underbrace{\left[D/Q \cdot P_i \cdot Q_P\right]}_{\text{Milk}}$$

where: D_{O_P} = maximum organ dose rate from particulate releases

Q_P = release rate of particulates, µCi/sec

other parameters as described for iodine, above.

a. **Thyroid Doses**

Release rate limit is 1500 mrem/year, using the average worst case x/Q and D/Q's and P_i values from *Table 1* results in:

i. ***Method 1***

UNIT 1

$$D_T = \underbrace{\left(5.1 x 10^{-8} \cdot 1.6 x 10^{7} \cdot Q_I\right)}_{\text{Inhalation}} + \underbrace{\left(2.7 x 10^{-9} \cdot 2.2 x 10^{10} \cdot Q_I\right)}_{\text{Vegetation}} +$$

$$\underbrace{\left(2.7 x 10^{-9} \cdot 6.3 x 10^{11} \cdot Q_I\right)}_{\text{Milk}} + \underbrace{\left(5.1 x 10^{-8} \cdot 1.3 x 10^{3} \cdot Q_H\right)}_{\text{Inhalation}} +$$

$$\underbrace{\left(5.1 x 10^{-8} \cdot 4.0 x 10^{3} \cdot Q_H\right)}_{\text{Vegetation}} + \underbrace{\left(5.1 x 10^{-8} \cdot 4.9 x 10^{3} \cdot Q_H\right)}_{\text{Milk}} =$$

$$0.82\,Q_I + 59.4\,Q_I + 1700\,Q_I + 6.63 x 10^{-5} Q_H + 2.04 x 10^{-4} Q_H + 2.50 x 10^{-4} Q_H =$$

$$1760\,Q_I + 5.20 x 10^{-4}\,Q_H$$

UNIT 2 and UNIT 3

$$D_T = \underbrace{\left(4.8 x 10^{-6} \cdot 1.6 x 10^{7} \cdot Q_I\right)}_{\text{Inhalation}} + \underbrace{\left(1.0 x 10^{-7} \cdot 2.2 x 10^{10} \cdot Q_I\right)}_{\text{Vegetation}} + \underbrace{\left(1.0 x 10^{-7} \cdot 6.3 x 10^{11} \cdot Q_I\right)}_{\text{Milk}} +$$

$$\underbrace{\left(4.8 x 10^{-6} \cdot 1.3 x 10^{3} \cdot Q_H\right)}_{\text{Inhalation}} + \underbrace{\left(4.8 x 10^{-6} \cdot 4.0 x 10^{3} \cdot Q_H\right)}_{\text{Vegetation}} + \underbrace{\left(4.8 x 10^{-6} \cdot 4.9 x 10^{3} \cdot Q_H\right)}_{\text{Milk}} =$$

$$76.8\,Q_I + 2200\,Q_I + 63{,}000\,Q_I + 6.24 \times 10^{-3} Q_H + 1.92 \times 10^{-2} Q_H + 2.35 \times 10^{-2} Q_H =$$

$$65{,}280\,Q_I + 4.90 \times 10^{-2}\,Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$1760\,Q_{I1} + 5.20 \times 10^{-4} Q_{H1} + 65{,}280\,Q_{I2} + 4.90 \times 10^{-2}\,Q_{H2} + 65{,}280\,Q_{I3} \quad +$$

$$4.90 \times 10^{-2}\,Q_{H3} \le 1500\ mrem/yr$$

dividing by 1500 gives:

$$1.17\,Q_{I1} + 43.5\,Q_{I2} + 43.5\,Q_{I3} + 3.47 \times 10^{-7}\,Q_{H1} + 3.27 \times 10^{-5}\,Q_{H2} + 3.27 \times 10^{-5}\,Q_{H3} \le 1$$

ii. ***Method 2***

For the 1st quarter, neglect both milk and vegetation doses (i.e., do inhalation dose calculations only).

UNIT 1

$$D_T = 0.82\,Q_I + 6.63 \times 10^{-5}\,Q_H$$

UNIT 2 and UNIT 3

$$D_T = 76.8\,Q_I + 6.24 \times 10^{-3}\,Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$0.82\,Q_{I1} + 6.63 \times 10^{-5}\,Q_{H1} + 76.8\,Q_{I2} + 6.24 \times 10^{-3}\,Q_{H2} + 76.8\,Q_{I3} \quad +$$

$$6.24 \times 10^{-3}\,Q_{H3} \le 1500\ mrem/yr$$

dividing by 1500 gives:

$$5.5 \times 10^{-4} Q_{I1} + 5.1 \times 10^{-2}\,Q_{I2} + 5.1 \times 10^{-2}\,Q_{I3} + 4.4 \times 10^{-8}\,Q_{H1} + 4.2 \times 10^{-6}\,Q_{H2} \quad +$$

$$4.2 \times 10^{-6}\,Q_{H3} \le 1$$

For the 4th quarter, neglect vegetation doses.

UNIT 1

$$D_T = 0.82\,Q_I + 1700\,Q_I + 6.63 \times 10^{-5}\,Q_H + 2.50 \times 10^{-4}\,Q_H = 1700\,Q_I + 3.16 \times 10^{-4}\,Q$$

UNIT 2 and UNIT 3

$$D_T = 76.8\,Q_I + 63000\,Q_I + 6.24 \times 10^{-3} Q_H + 2.35 \times 10^{-2} Q_H =$$

$$63{,}000\,Q_I + 2.97 \times 10^{-2}\,Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$1700\,Q_{I1} + 63{,}000\,Q_{I2} + 63{,}000\,Q_{I3} + 3.16 \times 10^{-4} Q_{H1} +$$

$$2.97 \times 10^{-2}\,Q_{H2} + 2.97 \times 10^{-2}\,Q_{H3} \leq 1500 \text{ mrem/yr}$$

dividing by 1500 gives:

$$1.13\,Q_{I1} + 42\,Q_{I2} + 42\,Q_{I3} + 2.11 \times 10^{-7}\,Q_{H1} +$$

$$1.98 \times 10^{-5} Q_{H2} + 1.98 \times 10^{-5}\,Q_{H3} \leq 1$$

iii. ***Method 3***

2nd and 3rd Quarters

Assuming *Appendix D.1* D/Q data for milk animals is acceptable.

UNIT 1

$$\left(5.1 \times 10^{-8} \cdot 1.6 \times 10^{7} \cdot Q_I\right) + \left(2.7 \times 10^{-9} \cdot 2.2 \times 10^{10} \cdot Q_I\right) + \left(6.5 \times 10^{-10} \cdot 6.3 \times 10^{11} \cdot Q_I\right)$$

$$5.2 \times 10^{-4} Q_H = D_T =$$

$$0.82\,Q_I + 59.4\,Q_I + 409.5\,Q_I + 5.2 \times 10^{-4}\,Q_H = 470\,Q_I + 5.2 \times 10^{-4}\,Q_H$$

UNIT 2 AND UNIT 3

$$\left(4.8 \times 10^{-6} \cdot 1.6 \times 10^{7} \cdot Q_I\right) + \left(1.0 \times 10^{-7} \cdot 2.2 \times 10^{10} \cdot Q_I\right) + \left(3.9 \times 10^{-9} \cdot 6.3 \times 10^{11} \cdot Q_I\right)$$

$$4.90 \times 10^{-2} Q_H = D_T =$$

$$76.8\,Q_I + 2200\,Q_I + 2460\,Q_I + 4.90 \times 10^{-2}\,Q_H = 4740\,Q_I + 4.90 \times 10^{-2}\,Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$470\,Q_{I1} + 4740\,Q_{I2} + 4740\,Q_{I3} + 5.2 \times 10^{-4} Q_{H1} +$$

$$4.90 \times 10^{-2}\,Q_{H2} + 4.90 \times 10^{-2}\,Q_{H3} \leq 1500 \text{ mrem/yr}$$

dividing by 1500 gives:

$$0.3\,Q_{I1} + 3.2\,Q_{I2} + 3.2\,Q_{I3} + 3.5 \times 10^{-7}\,Q_{H1} +$$

$$3.3 \times 10^{-5} Q_{H2} + 3.3 \times 10^{-5}\,Q_{H3} \leq 1$$

4th Quarter - Inhalation and milk pathways same as above, however delete vegetation contribution.

UNIT 1

$$D_T = 0.82\,Q_I + 409.5\,Q_I + 3.16 \times 10^{-4}\,Q_H$$

UNIT 2 and Unit 3

$$D_T = 76.8\,Q_I + 2460\,Q_I + 2.97 \times 10^{-2}\,Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year:

$$410\,Q_{I1} + 2540\,Q_{I2} + 2540\,Q_{I3} + 3.16 \times 10^{-4} Q_{H1} +$$

$$2.97 \times 10^{-2}\,Q_{H2} + 2.97 \times 10^{-2}\,Q_{H3} \leq 1500 \; mrem/yr$$

$$0.27\,Q_{I1} + 1.7\,Q_{I2} + 1.7\,Q_{I3} + 2.1 \times 10^{-7} Q_{H1} +$$

$$2.0 \times 10^{-5}\,Q_{H2} + 2.0 \times 10^{-5}\,Q_{H3} \leq 1$$

b. **Maximum Organ *(other than thyroid)* Doses**

Release rate limit is 1500 mrem/year. Using the 1980-1987 average worst case X/Q and D/Q's and P_i values (conservative mix)* from *Table 1* results in:

i. ***Method 1***

UNIT 1

$$D_O = \underbrace{\left(5.1 x 10^{-8} \cdot 1.6 x 10^{7} \cdot Q_P\right)}_{\text{Inhalation}} + \underbrace{\left(2.7 x 10^{-9} \cdot 2.6 x 10^{10} \cdot Q_P\right)}_{\text{Vegetation}} +$$

$$\underbrace{\left(2.7 x 10^{-9} \cdot 2.0 x 10^{11} \cdot Q_P\right)}_{\text{Milk}} + \underbrace{\left(5.1 x 10^{-8} \cdot 1.3 x 10^{3} \cdot Q_H\right)}_{\text{Inhalation}} +$$

$$\underbrace{\left(5.1 x 10^{-8} \cdot 4.0 x 10^{3} \cdot Q_H\right)}_{\text{Vegetation}} + \underbrace{\left(5.1 x 10^{-8} \cdot 4.9 x 10^{3} \cdot Q_H\right)}_{\text{Milk}} =$$

$$\underbrace{\left(0.82\,Q_P\right)}_{\text{Inh}} + \underbrace{\left(70.2\,Q_P\right)}_{\text{Veg}} + \underbrace{\left(540\,Q_P\right)}_{\text{Milk}} + \underbrace{\left(6.63 \times 10^{-5}\,Q_H\right)}_{\text{Inh}}$$

$$+ \underbrace{\left(2.04 \times 10^{-4}\,Q_H\right)}_{\text{Vegetation}} + \underbrace{\left(2.50 \times 10^{-4}\,Q_H\right)}_{\text{Milk}} =$$

$$611\,Q_P + 5.2 \times 10^{-4}\,Q_H$$

* Sr-90 values are too conservative. Review of the 1978-1988 effluent data shows Sr-90 has never contributed to greater than 2% of the total curies; use the next limiting nuclide (other than Sr-89). Comparison with *ODCM Rev. 0*, shows this results in a conservative calculation.

<u>UNIT 2 and UNIT 3</u>

$$D_O = \left(4.8 x 10^{-6} \cdot 1.6 x 10^{7} \cdot Q_P\right) + \left(1.0 x 10^{-7} \cdot 2.6 x 10^{10} \cdot Q_P\right) + \left(1.0 x 10^{-7} \cdot 2.0 x 10^{11} \cdot Q_P\right)$$

Inhalation Vegetation Milk

$$\left(4.8 x 10^{-6} \cdot 1.3 x 10^{3} \cdot Q_H\right) + \left(4.8 x 10^{-6} \cdot 4.0 x 10^{3} \cdot Q_H\right) + \left(4.8 x 10^{-6}\ x\ 4.9 x 10^{3} \cdot Q_H\right)$$

Inhalation Vegetation Milk

$$\left(76.8\, Q_P\right) + \left(2{,}600\, Q_P\right) + \left(20{,}000\, Q_P\right) + \left(6.24\ x\ 10^{-3} Q_H\right) +$$

Inh Veg Milk Inh

$$\left(1.92\ x\ 10^{-2} Q_H\right) + \left(2.35\ x\ 10^{-2}\ Q_H\right) =$$

Veg Milk

$$22{,}700\, Q_P + 4.90\ x\ 10^{-2} Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$611\, Q_{P1} + 22{,}700\, Q_{P2} + 22{,}700\, Q_{P3} + 5.2\ x\ 10^{-4}\ Q_{H1} + 4.90\ x\ 10^{-2}\ Q_{H2} +$$

$$4.90\ x\ 10^{-2}\ Q_{H3} \leq 1500\ mrem/yr$$

dividing by 1500 gives:

$$0.41\, Q_{P1} + 15.1\, Q_{P2} + 15.1\, Q_{P3} + 3.5\ x\ 10^{-7}\ Q_{H1} + 3.3\ x\ 10^{-5}\ Q_{H2} + 3.3\ x\ 10^{-5}\ Q_{H3} \leq$$

ii. ***Method 2***

For the 1st quarter, neglect both milk and vegetation doses (i.e., do inhalation dose calculations only).

<u>UNIT 1</u>

$$D_O = 0.82\, Q_P + 6.63\ x\ 10^{-5}\ Q_H$$

<u>UNIT 2 and UNIT 3</u>

$$D_O = 76.8\, Q_P + 6.24\ x\ 10^{-3} Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$0.82\, Q_{P1} + 76.8\, Q_{P2} + 76.8\, Q_{P3} + 6.63\ x\ 10^{-5} Q_{H1} +$$

$$6.24\ x\ 10^{-3}\ Q_{H2} + 6.24\ x\ 10^{-3}\ Q_{H3} \leq 1500\ mrem/yr$$

dividing by 1500 gives:

$$5.5\ x\ 10^{-4}\ Q_{P1} + 5.1\ x\ 10^{-2}\ Q_{P2} + 5.1\ x\ 10^{-2}\ Q_{P3} + 4.4\ x\ 10^{-8}\ Q_{H1} +$$

$$4.2\ x\ 10^{-6} Q_{H2} + 4.2\ x\ 10^{-6}\ Q_{H3} \leq 1$$

4th Quarter - Neglecting vegetation doses

UNIT 1

$$D_O = 0.82\,Q_P + 540\,Q_P + 6.63 \times 10^{-5} Q_H + 2.5 \times 10^{-4} Q_H = 541\,Q_P + 3.2 \times 10^{-4} Q_H$$

UNIT 2 and Unit 3

$$D_O = 76.8\,Q_P + 20{,}000\,Q_P + 6.24 \times 10^{-3}\,Q_H + 2.35 \times 10^{-2} Q_H = 20{,}100\,Q_P + 3.0 \times 10^{-2}\,Q$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

$$541\,Q_{P1} + 20{,}100\,Q_{P2} + 20{,}100\,Q_{P3} + 3.2 \times 10^{-4} Q_{H1} +$$

$$3.0 \times 10^{-2} Q_{H2} + 3.0 \times 10^{-2} Q_{H3} \leq 1500 \; mrem/yr$$

dividing by 1500 gives:

$$0.36\,Q_{P1} + 13.4\,Q_{P2} + 13.4\,Q_{P3} + 2.1 \times 10^{-7} Q_{H1} +$$

$$2.0 \times 10^{-5} Q_{H2} + 2.0 \times 10^{-5}\,Q_{H3} \leq 1$$

iii. *Method 3*

Assuming *Appendix D-1* D/Q data for milk animals is acceptable:

UNIT 1

2nd and 3rd Quarters

$$D_O = 0.82\,Q_P + 70.2\,Q_P + \left(6.5 \times 10^{-10} \cdot 2.0 \times 10^{11} \cdot Q_P\right) + 5.2 \times 10^{-4} Q_H =$$

$$0.82\,Q_P + 70.2\,Q_P + 130\,Q_P + 5.2 \times 10^{-4} Q_H = 201\,Q_P + 5.2 \times 10^{-4} Q_H$$

4th Quarter - Delete vegetation doses

$$D_O = 0.82\,Q_P + \left(6.5 \times 10^{-10} \cdot 2.0 \times 10^{11} \cdot Q_P\right) + 6.63 \times 10^{-5} \cdot Q_H + 2.5 \times 10^{-4} Q_H =$$

$$0.82\,Q_P + 130\,Q_P + 3.2 \times 10^{-4} Q_H = 131\,Q_P + 3.2 \times 10^{-4} Q_H$$

UNIT 2 and Unit 3

2nd and 3rd Quarters

$$D_O = 76.8\,Q_P + 2{,}600\,Q_P + \left(3.9 \times 10^{-9} \cdot 2.0 \times 10^{11} \cdot Q_P\right) + 4.9 \times 10^{-2} Q_H =$$

$$76.8\,Q_P + 2{,}600\,Q_P + 780\,Q_P + 4.9 \times 10^{-2} Q_H = 3{,}460\,Q_P + 4.9 \times 10^{-2} Q_H$$

4th Quarter - Delete vegetation doses

$$D_O = 76.8\,Q_P + \left(3.9 x 10^{-9} \cdot 2.0 x 10^{11} Q_P\right) + 6.24\ x\ 10^{-3} Q_H + 2.35\ x\ 10^{-2} Q_H =$$

$$76.8\,Q_P + 780\,Q_P + 3.0\ x\ 10^{-2} Q_H = 860\,Q_P + 3.0\ x\ 10^{-2} Q_H$$

Summing all three units, and setting ≤ 1500 mrem/year results in:

2nd and 3rd Quarters

$$201\,Q_{P1} + 3{,}460\,Q_{P2} + 3{,}460\,Q_{P3} + 5.2\ x\ 10^{-4} Q_{H1} +$$

$$4.9\ x\ 10^{-2} Q_{H2} + 4.9\ x\ 10^{-2} Q_{H3} \leq 1500\ mrem/yr$$

dividing by 1500 gives:

$$0.14\,Q_{P1} + 2.3\,Q_{P2} + 2.3\,Q_{P3} + 3.5\ x\ 10^{-7} Q_{H1} + 3.3\ x\ 10^{-5} Q_{H2} + 3.3\ x\ 10^{-5} Q_{H3} \leq 1$$

4th Quarter

$$131\,Q_{P1} + 860\,Q_{P2} + 860\,Q_{P3} + 3.2\ x\ 10^{-4} Q_{H1} +$$

$$3.0\ x\ 10^{-2} Q_{H2} + 3.0\ x\ 10^{-2} Q_{H3} \leq 1500\ mrem/yr$$

dividing by 1500 gives:

$$0.09\,Q_{P1} + 0.57\,Q_{P2} + 0.57\,Q_{P3} + 2.1\ x\ 10^{-7} Q_{H1} + 2.0\ x\ 10^{-5} Q_{H2} + 2.0\ x\ 10^{-5} Q_{H3} \leq 1$$

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

(1) Unit 1

From the *Table* in *Section D.2* of this *Appendix*, the maximum quarterly value of mrem/qtr. per µCi/sec is 3.7×10^{-4}. This factor is for the whole body. To convert to mrad air dose we must multiply by 2. There is a factor of 0.7 to convert 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)*. These factors were used to originally calculate the whole body results. Therefore, the conversion factor for the air dose is:

$$7.4 \times 10^{-4} \; mrad/qtr. \; per \; \mu Ci/sec \quad or$$

$$7.4 \times 10^{-4} \; \frac{mrad-sec}{qtr. - \mu Ci} \times 10^{6} \; \mu Ci/Ci \times 1.26 \times 10^{-7} \; qtr./sec$$

$$= 9.3 \times 10^{-5} \; mrad/Ci$$

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:

Less than 9.3×10^{-7} mrad/Ci

(2) Unit 2

Likewise, for Unit 2 from *Section D.2,* the maximum quarterly value of mrem/qtr. per µCi/sec is 2.5×10^{-3}.

Converting to mrad/Ci we have:

$2.5 \times 10^{-3} \times 2 \times 10^{6} \times 1.26 \times 10^{-7} = 6.3 \times 10^{-4}$ 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	1979	1980	1981	1982
1st qtr.	2.9	3.1	6.9	3.1	2.8	2.5	1.3
2nd qtr.	2.9	3.0	2.8	3.3	2.7	2.4	2.3
3rd qtr.	3.5	2.5	3.0	3.1	1.7	2.2	2.2
4th qtr.	3.0	3.0	3.0	3.0	1.8	2.2	2.4

	1983	1984	1985	1986	1987
1st qtr.	2.6	2.7	2.8	1.7	2.8
2nd qtr.	2.7	2.8	*	1.8	2.3
3rd qtr.	*	2.8	1.6	2.2	2.6
4th qtr.	*	2.9	2.1	*	2.8

*No continuous noble gas releases for these quarters

The average ratio = 2.7

Beta air dose = 1.7 x 10^{-3} mrad/Ci

(3) Unit 3

Again, as mentioned in *Section D.2*, since the average X/Q's are less for Unit 3 than for Unit 2, a conservative estimate for Unit 3 would be to assume its values would be the same as for Unit 2. This is confirmed by the 1986-1987 data for Unit 3.

5. Section D.2.b

Unit 1 Finite Cloud Code

Year	Quarter	Curies of Xe-138	Dose (mrem) due to Xe-138	Dose/Curie	Wind Freq. to NE, %
1976	1	2.4 (+4)	0.29	1.2 (-5)	
	2	3.9 (+4)	0.61	1.6 (-5)	
	3	3.3 (+4)	0.52	1.6 (-5)	
	4	7.5 (+3)	0.08	1.0 (-5)	
1977	1	2.1 (+4)	0.19	8.9 (-6)	
	2	1.9 (+4)	0.22	1.2 (-5)	
	3	3.4 (+4)	0.52	1.5 (-5)	
	4	3.4 (+4)	0.22	6.4 (-6)	
1978	1	6.5 (+4)	0.31	4.8 (-6)	
	2	4.7 (+4)	0.57	1.2 (-5)	
	3	9.0 (+2)	0.019	2.1 (-5)	
	4	1.6 (+3)	0.015	9.2 (-6)	
1979	1	1.98 (+3)	0.010	5.1 (-6)	
	2	8.42 (+2)	0.013	1.5 (-5)	
	3	1.05 (+3)	0.028	2.7 (-5)	
	4	1.06 (+3)	0.019	1.8 (-5)	
1980	1	1.09 (+3)	1.6 (-2)	1.5 (-5)	6.5
	2	5.42 (+2)	1.5 (-2)	2.9 (-5)	11.2
	3	2.43 (+3)	6.3 (-2)	2.6 (-5)	19.5
	4	3.54 (+1)	4.3 (-4)	1.2 (-5)	7.4
1981	1	-	-	-	9.2
	2	1.41 (+2)	3.4 (-3)	2.4 (-5)	14.9
	3	3.63 (+3)	4.8 (-2)	1.3 (-5)	9.6
	4	8.48 (+2)	7.7 (-3)	9.0 (-6)	4.5
1982	1	2.40 (+2)	2.9 (-3)	1.2 (-5)	7.3
	2	3.59 (+1)	6.5 (-4)	1.8 (-5)	11.2
	3	1.09 (+3)	0.019	1.8 (-5)	13.2
	4	-	-	-	13.0
1983	1	8.89 (+1)	3.0 (-4)	3.4 (-6)	3.3
	2	4.52 (+2)	1.1 (-2)	2.4 (-5)	12.0
	3	3.55 (+2)	1.1 (-2)	3.0 (-5)	14.4
	4	2.11 (+2)	2.3 (-3)	1.1 (-5)	5.6
1984	1	5.77 (+2)	7.6 (-3)	1.3 (-5)	5.3
	2	1.28 (+2)	2.9 (-3)	2.3 (-5)	10.6
	3	7.30 (+2)	2.4 (-2)	3.3 (-5)	16.1
	4	5.10 (0)	1.8 (-4)	3.6 (-5)*	8.7

Unit 1 Finite Cloud Code *(Cont'd.)*

Year	Quarter	Curies of Xe-138	Dose (mrem) due to Xe-138	Dose/Curie	Wind Freq. to NE %
1985	1	1.07 (+2)	1.3 (-3)	1.2 (-5)	7.5
	2	1.58 (+2)	4.1 (-3)	2.6 (-5)	13.5
	3	-	-	-	13.7
	4	3.46 (+1)	8.8 (-4)	2.5 (-5)	11.0
1986	1	5.76 (0)	2.8 (-4)	4.8 (-5)*	9.2
	2	3.70 (+2)	9.3 (-3)	2.5 (-5)	14.0
	3	6.40 (+2)	1.3 (-2)	2.0 (-5)	14.9
	4	3.36 (+2)	3.5 (-3)	1.1 (-5)	9.3
1987	1	1.83 (+3)	1.6 (-2)	8.5 (-6)	4.4
	2	1.21 (+3)	2.0 (-2)	1.6 (-5)	10.9
	3	-	-	-	12.3
	4	5.08 (0)	1.1 (-4)	2.2 (-5)	10.8

* High values caused by dose contribution of other isotopes. Low doses prevented breakdown by isotope. Therefore, discard these values. Review of wind frequencies for these quarters indicates that those are not critical quarters.

The above table attempts to normalize the dose at the maximum location from a particular radionuclide (Xe-138). However, the method for calculating the Xe-138 contribution is not exact; it is based upon % contribution to the population dose. In several cases, there is only a small contribution from Xe-138, causing much error in the calculations. Therefore, the wind frequencies should also be evaluated. Note that the worst case critical sector is towards the NE (nearest residence and high probability of wind direction). Therefore, using the last two columns from above indicates that the worst case quarters are either 3rd quarter 1980 or 3rd quarter 1984. Test runs of these two reveals that the worst is in 1980.

6. **Section D.3**

Doses are calculated using the methods of *NUREG-0133* dated October, 1978 and *NRC Regulatory Guide 1.1.09 Revision 1*. Note that the equation on *page 27 of NUREG-0133* (for all radionuclides, except tritium) has been corrected for the elemental iodine fraction, as in *Regulatory Guide 1.109, Revision 1*. Since the locations of milk producing animals causes significant variations in the dose calculations (substantial variations in D/Q's), use 3 methods when performing these calculations.

Method 1

Assume worst case locations (i.e., milk animals located at maximum resident D/Q location), vegetables harvested throughout the year, and milk animals on pasture throughout the year.

Method 2

Assume worst case quarterly x/Q and D/Q as above, however:

i. If 1st quarter, neglect vegetation and milk doses.

ii. If 4th quarter, neglect vegetation doses.

iii. For batch releases (including weekly continuous releases, if necessary), evaluate other periods of time where the above may apply.

__Method 3__

Determine if the maximum quarterly D/Q data from *Appendix D.1* is acceptable to use (i.e., no milk animal likely to be more critical than the data for 1983-1987). If acceptable, use worst case year D/Q for milk locations. If not, an acceptable D/Q for use is the worst case quarter of at least the past three years.

Dose formula for iodine is:

$$D_{QT_I} = \underbrace{\left[X/Q \cdot O_i \cdot C_I\right]}_{\text{Inhalation}} + \underbrace{\left[D/Q \cdot O_i \cdot C_I\right]}_{\text{Vegetation}} + \underbrace{\left[D/Q \cdot O_i \cdot C_I\right]}_{\text{Milk}}$$

where: D_{QT_I} = quarterly thyroid dose from iodine releases

C_I = curies of iodine-131 released

X/Q = meteorological dispersion factor, sec/m^3

D/Q = deposition factor, m^{-2}

O_i = P_i x 3.17 x 10^{-2}*, mrem • m^3/Ci • sec. for inhalation and mrem • m^2/Ci for food consumption

P_i = values derived from *NUREG-0133* and *Regulatory Guide 1.109* (see *Table 1*).

* µCi/sec per Ci/yr conversion factor

Dose formula for tritium is:

$$D_{QT_H} = \underbrace{\left[X/Q \cdot O_i \cdot C_H\right]}_{\text{Inhalation}} + \underbrace{\left[X/Q \cdot O_i \cdot C_H\right]}_{\text{Vegetation}} + \underbrace{\left[X/Q \cdot O_i \cdot C_H\right]}_{\text{Milk}}$$

where: D_{QT_H} = quarterly thyroid (or any other organ) dose from tritium releases

C_H = curies of tritium released

Other parameters as described above, except units for O_i and P_i. Since milk and vegetable doses from tritium are related to X/Q and not D/Q, use the units for inhalation (see *NUREG-0133* and/or *Regulatory Guide 1.109, Revision 1* for details).

Dose formula for particulates is:

$$D_{QO_P} = \underbrace{\left[X/Q \cdot O_i \cdot C_P\right]}_{\text{Inhalation}} + \underbrace{\left[D/Q \cdot O_i \cdot C_P\right]}_{\text{Vegetation}} + \underbrace{\left[D/Q \cdot O_i \cdot C_P\right]}_{\text{Milk}}$$

where: D_{QO_P} = quarterly maximum organ dose from particulate releases

C_P = curies of particulates released and other parameters as described for iodine, above.

a. UNIT 1

i. *Method 1*

Using the worst case quarters as explained earlier and P_i's* from *Table 1* results in:

* For particulates, Sr-90 P_i values are too conservative. Review of the 1978-1988 effluent data shows that Sr-90 has not contributed to greater than 2% of the total curies. Therefore use the next most limiting nuclide (other than Sr-89). Comparison with *ODCM Rev. 0* shows that this still results in a conservative calculation.

$$D_{QT_I} = \Big[\underbrace{\left(6.3 \times 10^{-8} \cdot 1.6 \times 10^{7}\right)}_{\text{Inhalation}} + \underbrace{\left(5.9 \times 10^{-9} \cdot 2.2 \times 10^{10}\right)}_{\text{Vegetation}} + \underbrace{\left(5.9 \times 10^{-9} \cdot 6.3 \times 10^{11}\right)}_{\text{Milk}}\Big] \cdot 3.17 \times 10^{-2}\, C_I$$

$$= \Big[1.0 + 130 + 3717\Big] \cdot 3.17 \times 10^{-2}\, C_I$$

$$= \underbrace{0.032}_{\text{Inhalation}} + \underbrace{4.1}_{\text{Vegetation}} + \underbrace{118}_{\text{Milk}} = 122\, C_I$$

$$D_{QT_{H-3}} = 6.3 \times 10^{-8} \Big[\underbrace{\left(1.3 \times 10^{3}\right)}_{\text{Inhalation}} + \underbrace{\left(4.0 \times 10^{3}\right)}_{\text{Vegetation}} + \underbrace{\left(4.9 \times 10^{3}\right)}_{\text{Milk}}\Big] \cdot 3.17 \times 10^{-2}\, C_H$$

$$= \left(\underbrace{2.60 \times 10^{-6}}_{\text{Inhalation}} + \underbrace{7.99 \times 10^{-6}}_{\text{Vegetation}} + \underbrace{9.79 \times 10^{-6}}_{\text{Milk}}\right) C_{H_3} = 2.04 \times 10^{-5}\, C_H$$

$$D_{QO_P} = \Big[\underbrace{\left(6.3 \times 10^{-8} \cdot 1.6 \times 10^{7}\right)}_{\text{Inhalation}} + \underbrace{\left(5.9 \times 10^{-9} \cdot 2.6 \times 10^{10}\right)}_{\text{Vegetation}} + \underbrace{\left(5.9 \times 10^{-9} \cdot 2.0 \times 10^{11}\right)}_{\text{Milk}}\Big] \cdot$$

$$3.17 \times 10^{-2}\, C_P = \left(1.0 + 153.4 + 1{,}180\right) \cdot 3.17 \times 10^{-2}\, C_P$$

$$= \left(\underbrace{0.032}_{\text{Inhalation}} + \underbrace{4.86}_{\text{Vegetation}} + \underbrace{37.41}_{\text{Milk}}\right) C_P = 42.3\, C_P$$

ii. *Method 2*

Use same formulas as for *Method 1*, however, delete vegetables and/or milk when applicable.

iii. *Method 3*

After review of existing cow and goat farms, if the 1983-1987 milk animal D/Q data is determined to be acceptable, then:

Milk Pathway Doses:

$$D_{QT_I} = \left(1.4 \times 10^{-9} \times 6.3 \times 10^{11}\right) \cdot 3.17 \times 10^{-2}\, C_I = 28\, C_I$$

$$D_{QT_H} = 9.8 \times 10^{-6}\, C_H \quad (\textit{Same as Method } 1)$$

$$D_{QO_P} = \left(1.4 \times 10^{-9} \times 2.0 \times 10^{11}\right) \cdot 3.17 \times 10^{-2}\, C_P = 8.9\, C_P$$

b. **UNIT 2 and UNIT 3**

i. ***Method 1***

Using the worst case quarters as explained earlier and P_i's from *Table 1* results in:

$$D_{QT_I} = \Big[\underbrace{\left(8.1 \times 10^{-6} \cdot 1.6 \times 10^{7}\right)}_{\text{Inhalation}} + \underbrace{\left(1.5 \times 10^{-7} \cdot 2.2 \times 10^{10}\right)}_{\text{Vegetation}} + \underbrace{\left(1.5 \times 10^{-7} \cdot 6.3 \times 10^{11}\right)}_{\text{Milk}}\Big] \cdot$$

$$3.17 \times 10^{-2}\, C_I = \left(130 + 3300 + 94{,}500\right) \cdot 3.17 \times 10^{-2}\, C_I$$

$$= \Big(\underbrace{4.1}_{\text{Inhalation}} + \underbrace{105}_{\text{Vegetation}} + \underbrace{2996}_{\text{Milk}}\Big)\, C_I = 3.1 \times 10^{3}\, C_I$$

$$D_{QT_H} = 8.1 \times 10^{-6} \Big[\underbrace{\left(1.3 \times 10^{3}\right)}_{\text{Inhalation}} + \underbrace{\left(4.0 \times 10^{3}\right)}_{\text{Vegetation}} + \underbrace{\left(4.9 \times 10^{3}\right)}_{\text{Milk}}\Big] \cdot 3.17 \times 10^{-2}\, C_H$$

$$= \Big(\underbrace{3.33 \times 10^{-4}}_{\text{Inhalation}} + \underbrace{1.03 \times 10^{-3}}_{\text{Vegetation}} + \underbrace{1.26 \times 10^{-3}}_{\text{Milk}}\Big)\, C_H = 2.62 \times 10^{-3}\, C_H$$

$$D_{QO_P} = \Big[\underbrace{\left(8.1 \times 10^{-6} \cdot 1.6 \times 10^{7}\right)}_{\text{Inhalation}} + \underbrace{\left(1.5 \times 10^{-7} \cdot 2.6 \times 10^{10}\right)}_{\text{Vegetation}} + \underbrace{\left(1.5 \times 10^{-7} \cdot 2.0 \times 10^{11}\right)}_{\text{Milk}}\Big] \cdot$$

$$3.17 \times 10^{-2}\, C_P = \left(130 + 3{,}900 + 3.0 \times 10^{4}\right) \cdot 3.17 \times 10^{-2}\, C_P$$

$$= \Big(\underbrace{4.1}_{\text{Inhalation}} + \underbrace{124}_{\text{Vegetation}} + \underbrace{951}_{\text{Milk}}\Big)\, C_P = 1{,}080\, C_P$$

ii. ***Method 2***

Use same formulas as for *Method 1*, however, delete vegetables and/or milk when applicable.

iii. ***Method 3***

After review of existing cow and goat farms, if the D/Q for milk animals for the 1983-1987 data is determined to be acceptable, then:

Milk Pathway Doses:

$$D_{QT_I} = \left(6.1 \times 10^{-9} \times 6.3 \times 10^{11}\right) \cdot 3.17 \times 10^{-2}\ C_I = 122\, C_I$$

$$D_{QT_H} = 1.3 \times 10^{-3}\ C_H \quad (\textit{Same as Method } 1)$$

$$D_{QO_P} = \left(6.1 \times 10^{-9} \times 2.0 \times 10^{11}\right) \cdot 3.17 \times 10^{-2}\ C_P = 40\, C_P$$

TABLE 1

DOSE FACTORS FOR IODINES & PARTICULATES

P_i*

Radionuclide	(mrem/yr per µCi/m³) Inhalation	(m² mrem/yr per µCi/sec) Vegetables	Goat Milk	Cow Milk
H-3	1.3 (3)	4.0 (3)**	4.9 (3)**	
Cr-51	2.1 (4)	6.4 (6)		
Mn-54	2.0 (6)	3.0 (9)		
Fe-59	1.5 (6)	6.8 (8)		
Co-58	1.3 (6)	3.8 (8)		
Co-60	8.7 (6)	2.1 (9)		
Zn-65	1.2 (6)	2.2 (9)		1.9 (10)
Rb-86	2.0 (5)			
Sr-89	2.4 (6)	3.7 (10)	2.7 (10)	1.3 (10)
Sr-90	1.1 (8)	1.25 (12)	2.6 (11)	1.2 (11)
Y-91	2.9 (6)			
Zr-95	2.7 (6)			
Nb-95	7.5 (5)			
Ru-103	7.8 (5)			
Ru-106	1.6 (7)	1.2 (10)		
Ag-110m	6.8 (6)			
Te-127m	1.7 (6)			
Te-129m	2.0 (6)			
Cs-134	1.1 (6)	2.6 (10)	2.0 (11)	6.8 (10)
Cs-136	1.9 (5)			
Cs-137	9.1 (5)	2.4 (10)	1.8 (11)	6.0 (10)
Ba-140	2.0 (6)			
Ce-141	6.1 (5)			
Ce-144	1.3 (7)	1.0 (10)		
I-131	1.6 (7)	2.2 (10)	6.3 (11)	5.3 (11)
I-133	3.9 (6)	4.0 (8)	5.6 (9)	4.7 (9)

* P_i are the inhalation and consumption factors derived from *NRC Regulatory Guide1.109, Rev. 1*. For inhalation, the teen is the critical age group for all nuclides except Rb-86, Cs-137, I-131, and I-133, which are for the child. For vegetables, the child is critical; for milk, the infant. Maximum organs are: whole body for H-3, bone for Sr-90 and thyroid for I-131, 133.

** Same units as for Inhalation for H-3, based on *NUREG 0133* assumptions.

*DERIVATION OF FACTORS FOR TABLE 1**

1. Vegetation Factors

a. H-3

$$R_i = K^1 K^{11} \left[U_a^L f_l + U_a^S f_g\right] \left(DFL_i\right)_a \left[0.75\left(0.5/H\right)\right]$$

From page 36 of NUREG-0133

$K^1 = 10^6$ $\quad$ $DFL_{H-3} = 2.03 \times 10^{-7}$

$K^{11} = 10^3$ $\quad$ $f_l = 1.0$

$U_a^L = 26$ (*for child*) $\quad$ $f_s = 0.76$

$U_a^S = 520$ (*for child*) $\quad$ $H = 8\ g/m^3$

$$R_i = 10^6 \cdot 10^3 \left[26\left(1.0\right) + 520\left(.76\right)\right] 2.03 \times 10^{-7}\left(0.75 \times 0.5/8\right) = 4.01 \times 10^3$$

b. Iodine - 131, 133

$$R_i^V \left[D/Q\right] = K^1 \left[\frac{(r)}{Y_v\left(\lambda_i + \lambda_w\right)}\right] \left(DFL_i\right)_a \left[U_a^L f_l e^{-\lambda_i t_l}\right] 0.5$$

From page 35 of NUREG-0133, except last term was deleted since it is negligible for iodine-131 and 133 and accounting for elemental iodine fraction.

$K^1 = 10^6$ $\quad$ $U_a = 26$ (*child*), 64 (*adult*)

$r = 1.0$ $\quad$ $f_l = 1.0$

$Y_v = 2$ $\quad$ $\lambda_i = 9.97 \times 10^{-7} \left(I-131\right)$

$DFL = 5.72 \times 10^{-3} \left(I-131\right)$ $\quad$ $\lambda_i = 9.35 \times 10^{-6} \left(I-133\right)$

$DFL = 1.36 \times 10^{-3} \left(I-133\right)$ $\quad$ $t_l = 8.6 \times 10^4\ sec$

$\lambda_w = 5.73 \times 10^{-7}$

$$R_i = 10^6 \times \left[\frac{1}{2\left(\lambda_i + \lambda_w\right)}\right] DCF_i \left(26\, e^{-\lambda_i t_l}\right)\left(0.5\right)$$

for I-131:

$$R_i = 10^6 \frac{1}{2\left(1.57 \times 10^{-6}\right)} \times 5.72 \times 10^{-3} \left(26 \times 0.9178\right) \left(0.5\right) = 2.17 \times 10^{10}$$

for I-133:

$$R_i = 10^6 \frac{1}{2\left(9.92 \times 10^{-6}\right)} \times 1.36 \times 10^{-3} \left(26 \times 0.4475\right) \left(0.5\right)$$

$$= 3.99 \times 10^8 \simeq 4.0 \times 10^8$$

c. **Sr-90**

$$R_i^V \left[D/Q\right] = K^1 \left[\frac{(r)}{Y_v\left(\lambda_i + \lambda_w\right)}\right] \left(DFL_i\right)_a \left[U_a^L f_l e^{-\lambda_i t_l} + U_a^S f_g e^{-\lambda_i t_h}\right]$$

From page 35 of NUREG-0133

$K^1 = 10^6$

$r = 0.2$

$Y_v = 2$

$\lambda_i + \lambda_w = 5.738 \times 10^{-7}$

$DFL_{Sr-90} = 1.70 \times 10^{-2}$ (*child*)

$= 7.85 \times 10^{-3}$ (*adult*)

$U_a^L = 26$ (*child*), 64 (*adult*)

$U_a^S = 520$ (*child*), 520 (*adult*)

$f_l = 1.0$

$f_g = 0.76$

$\lambda_i = 7.85 \times 10^{-10}$

$t_l = 8.6 \times 10^4$ *sec*

$t_h = 5.16 \times 10^6$ *sec*

$$e^{-\lambda_i t_l} = 1 = e^{-\lambda_i t_h}$$

$$R_i^V \left[D/Q\right] = 10^6 \left[\frac{0.2}{2\left(5.738 \times 10^{-7}\right)}\right] 1.7 \times 10^{-2} \left[\left(1 \times 26\right) + \left(.76 \times 520\right)\right]$$

$$= 2.96 \times 10^9 \left(26 + 395.2\right) = 1.25 \times 10^{12}$$

2. Milk Factors

a. H-3

$$P_i = K^1 K^{111} F_m Q_f U_{ap} DFL_i \left[0.75 \left(0.5/H\right)\right]$$

From page 27 of NUREG-0133

$K^1 = 10^6$ $\quad U_{ap} = 330$ (*for infant*)

$K^{111} = 10^3\ gm/Kg$ $\quad DFL_i = 3.08 \times 10^{-7}$

$F_m = 0.17$ (*for goat*) $\quad H = 8$

$Q_f = 6$ (*for goat*)

$$P_i = 10^6 \cdot 10^3 \left(0.17\right)\left(6\right)\left(330\right)\left(3.08 \times 10^{-7}\right) \times \frac{.75 \times .5}{8}$$

$$= 4860 \text{ (for goat)}$$

$$= 2400 \text{ (for cow – see NUREG.–0133)}$$

b. Iodine - 131, 133

$$P_i = \frac{K^1 Q_f U_{ap}}{Y_p} \frac{rF_m}{\lambda_i + \lambda_w} DFL_i \left(e^{-\lambda_i t_f}\right)$$

From page 26 of NUREG-0133, however, multiply this by 0.5 elemental iodine fraction per guidance in *NRC Regulatory Guide 1.109, page 26.*

$Y_p = 0.7$ $\quad F_m = 0.06$

$r = 1.0$ *for iodine* $\quad t_f = 1.73 \times 10^5\ sec$

$\lambda_i = 9.97 \times 10^{-7}$ *for* I–131 $\quad DFL_{I-131} = 1.39 \times 10^{-2}$

$\lambda_i = 9.35 \times 10^{-6}$ *for* I–133 $\quad DFL_{I-133} = 3.31 \times 10^{-3}$

$\lambda_w = 5.73 \times 10^{-7}\ sec^{-1}$

and other factors as shown above.

for I-131:

$$P_i = 7.5 \ x \ 10^{11} \left(e^{-\lambda_i t_f}\right) = 7.5 \ x \ 10^{11} \ x \ 0.842 = 6.32 \ x \ 10^{11}$$

for I-133:

$$P_i = 2.83 \ x \ 10^{10} \left(e^{-\lambda_i t_f}\right) = 2.83 \ x \ 10^{10} \left(0.198\right) = 5.62 \ x \ 10^{9}$$

c. **Sr-90**

Same equation as for iodines, except disregard elemental iodine fraction and:

$\lambda_i = 7.85 \ x \ 10^{-10}$ $\lambda_i + \lambda_w = 5.738 \ x \ 10^{-7}$

$r = 0.2$ $DFL_{Sr-90} = 1.85 \ x \ 10^{-2}$

$F_m = 0.014 \ (for\ goat)$

$$P_i = 2.83 \ x \ 10^{9} \ \frac{r \ F_m}{\lambda_i + \lambda_w} \ DFL_i \left(e^{-\lambda_i t_f}\right)$$

$$= 2.55 \ x \ 10^{11} \ x \left(e^{-\lambda_i t_f}\right) = 2.6 \ x \ 10^{11}$$

* Comparisons of calculations performed using these values with calculations from GASPAR (NRC computer code) verify these factors.

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 *Regulatory Guide 1.109* to those in *Rev. 1*.

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

1. Real-time meteorology using a X/Q, D/Q model which incorporates the methodology of *Regulatory Guide 1.111*. Meteorology is determined separately for continuous releases and batch releases

2. 100% of vegetation grown locally, 76% of vegetation intake from garden, harvest season from April through September

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 nearest land site boundary with maximum decayed X/Q, and at the nearest vegetable garden (assumed to be nearest residence) and 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 radionuclides. 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 upon a standard sector averaged diffusion equation.

APPENDIX 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-2*.

Location Number	Name	Direction & Distance From Release Point***	Sample Types
1-I*	On-site - Old Millstone Rd.	0.6 Mi, NNW	TLD, Air Particulate, Iodine, Vegetatio
2-I	On-site - Weather Shack	0.3 Mi, S	TLD, Air Particulate, Iodine
3-I	On-site - Bird Sanctuary	0.3 Mi, NE	TLD, Air Particulate, Iodine
4-I	On-site - 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	Environmental Lab Dock	0.3 Mi, SE	TLD
8-I	Environmental Lab	0.3 Mi, SE	TLD
9-I	Bay Point Beach	0.4 Mi, W	TLD
10-I	Pleasure Beach	1.2 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	11.5 Mi, ENE	TLD
14-C	Ledyard, CT	12.0 Mi, NE	TLD
15-C	Norwich, CT	14.0 Mi, N	TLD, Air Particulate, Iodine
16-C	Old Lyme, CT	8.8 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	6.0 Mi, N	Milk
20-I	Cow Location #2	9.5 Mi, WNW	Milk
21-I	Cow Location #3	13.0 Mi, ENE	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	West Jordan Cove	0.4 Mi, NNE	Clams
30-C	Golden Spur	4.7 Mi, NNW	------------
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

Sampling Locations (Cont'd.)

Location Number	Name	Direction & Distance From Release Point***	Sample Types
34-I	Thames River Yacht Club	4.0 Mi, ENE	Bottom Sediment
35-I	Niantic Bay	0.3 Mi, WNW	Lobster, Fish
36-I	Black Point	3.0 Mi, WSW	Oysters
37-C	Giant's Neck	3.5 Mi, WSW	Bottom Sediment, Oysters, Seawater
38-I	Waterford Shellfish Bed #1	1.0 Mi, NW	Clams

*I = Indicator **C = Control

***The release points are the MP1 stack for terrestial locations and the end of the quarry for aquatic locations.

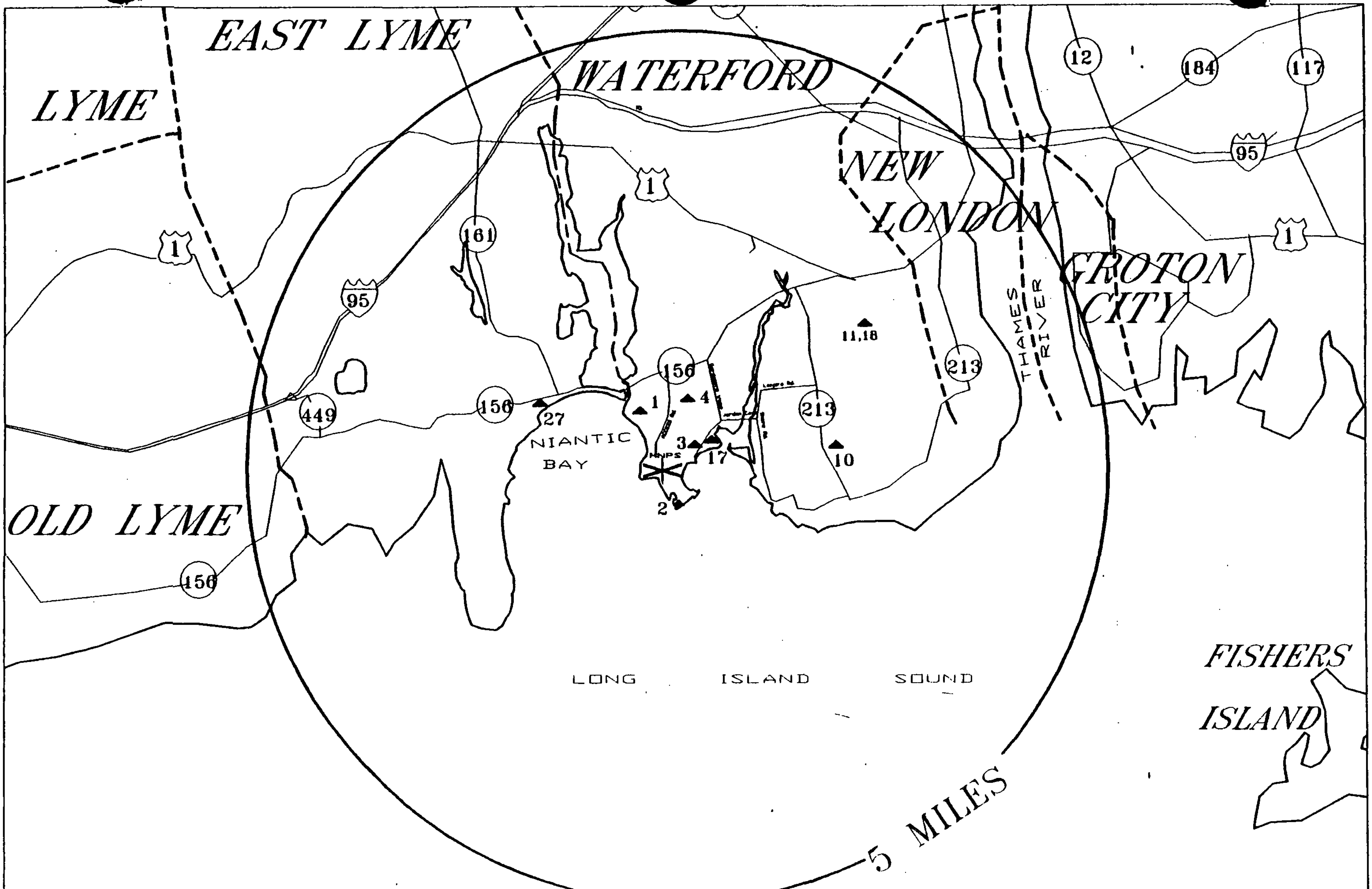

FIGURE G-1
Inner Air Particulate and Vegetation Monitoring Stations

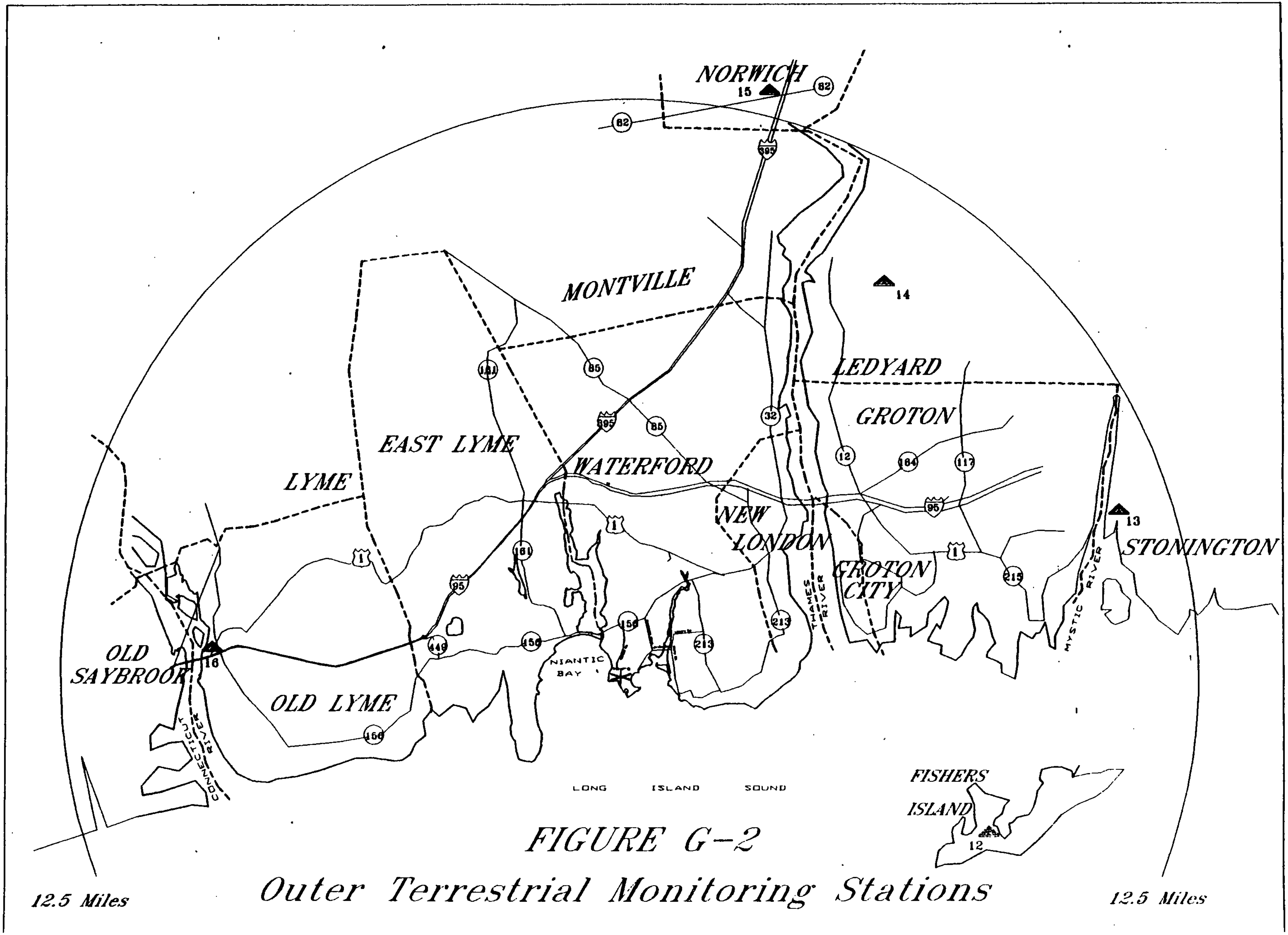

FIGURE G-2

Outer Terrestrial Monitoring Stations

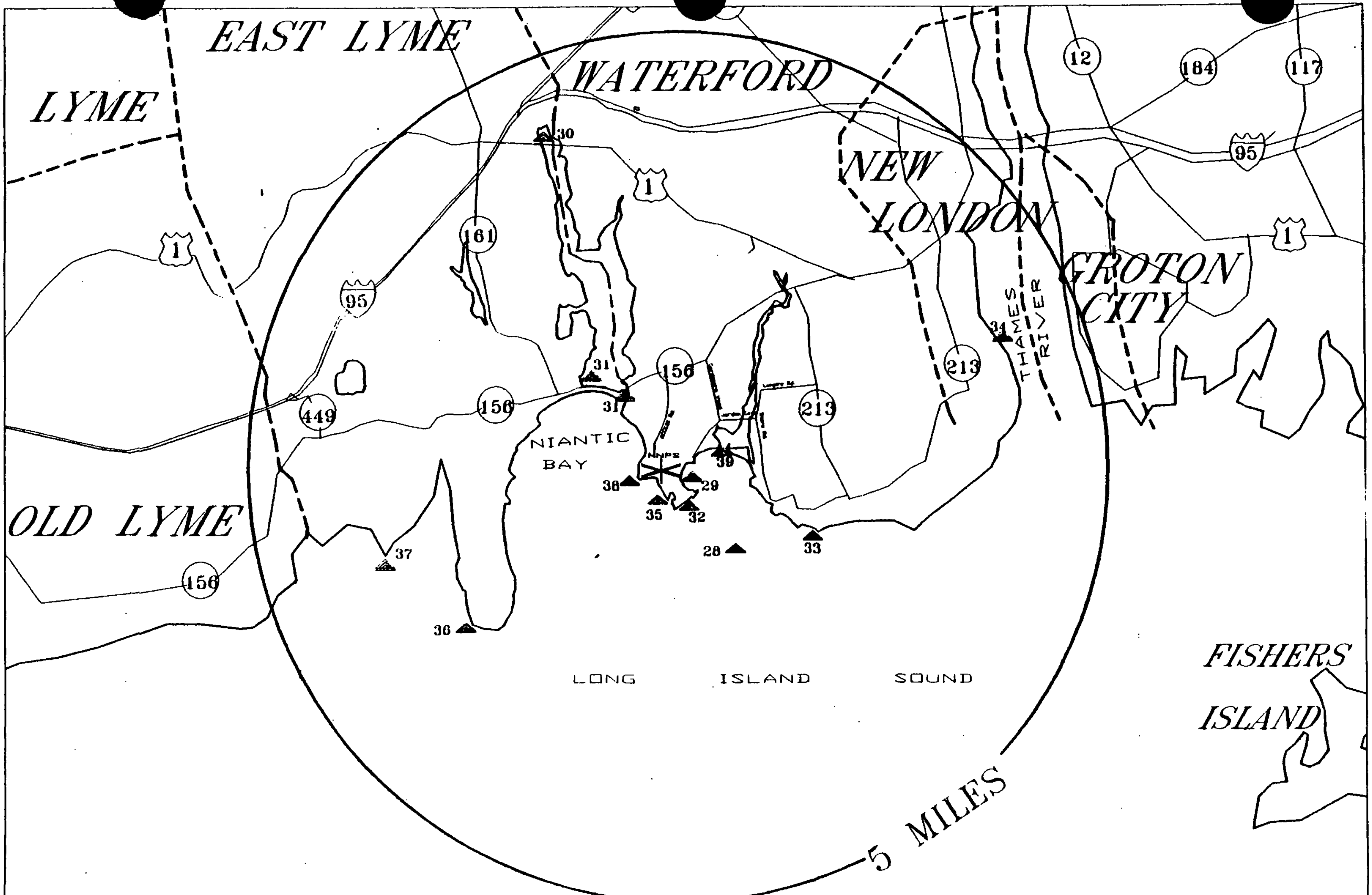

FIGURE G-3
Aquatic Sampling Stations