FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT

CHEMISTRY OPERATING PROCEDURE C-200

REVISION 0

OFFSITE DOSE CALCULATION MANUAL

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INTRODUCTION

This manual provides the methodology to calculate radiation dose, to individuals in the vicinity of the St. Lucie site, from radioactive gaseous and liquid effluents. It also provides methodology for calculating effluent monitor setpoints and allowable release rates to ensure compliance with the STS and 10CFR20 release criteria. The in-plant procedures specify what sections of the ODCM should be completed to calculate the dose to an individual.

The ODCM follows the methodology and models suggested by NUREG-0133 (Nov 1978) and Regulatory Guide 1.109. Simplifying assumptions have been applied where applicable to provide a more workable document for implementing the Technical Specification requirements. Alternate calculation methods may be used from those presented as long as the overall methodology does not change or as long as the alternative methods provide results that are more limiting. Also, as available, the most up-to-date revision of the Regulatory Guide 1.109 dose conversion factors and environmental transfer factors may be substituted for those currently included and used in this document.

β - dose (dose rate) from Beta radiation

CC - cubic centimeter

Ci - Curies - a unit of radioactivity see μCi

C_i - activity for concentration of a nuclide in the release source. Units of μCi, μCi/cc, or μCi/ml

CFR - Code of Federal Regulations

Dose - The exposure, in mrem or mrad, the organ or the individual receives from radioactive effluents.

Dose Factor - Normally, a factor that converts the effect of ingesting radioactive material into the body, to dose to a specific organ. Body elimination, radioactive decay, and organ uptake are some of the factors that determine a dose factor for a given nuclide.

Dose Pathway - A specific path that radioactive material physically travels through prior to exposing an individual to radiation. The Grass-Cow-Milk-Infant is a dose pathway.

Dose Rate - The dose received per unit time.

$\overline{(D/Q)}$ - a long term D over Q - a factor with units of $1/M^2$ which describes the deposition of particulate matter from a plume at a point downrange from the source. It can be thought of as what part of the cloud is going to fallout and deposit over one square meter of ground.

Gamma - γ - a gamma photon - the dose from Gammas in air etc.

Ground Plane - Radioactive material deposited uniformly over the ground emits radiation that produces an exposure pathway when an individual is standing, sitting, etc. in the area. It is assumed that an adult receives the same exposure as an infant, regardless of the physical height differences. Only the total body is considered for the ODCM.

H-3 - Hydrogen-3, or Tritium, a weak Beta emitter.

I&8DP - Radioiodines and particulates with half-lives greater than 8 days

LCO - Limiting condition for operation in STS

m^3 - cubic meters

m^2 - square meters

MPC - Maximum Permissible Concentration

nuclide - for the purposes of this manual, a radioactive isotope. nuclide (i) signifies a specific nuclide, the 1st, 2nd, 3rd one under consideration. If nuclide (i) is I-131, then the Mi (dose factor) under consideration should be M_{I-131} for example.

Organ - For the ODCM either the bone, liver, thyroid, kidney, lung, GI-LLI, or the T. Body. T. Body (Total Body) is considered an organ for ease of writing the methodology in the ODCM.

$\dot{Q}_i$ - Q_i - dotted - Denotes a release rate in μCi/sec for nuclide(i).

Q_i - Denotes μCi of nuclide (i) released over a specified time interval.

Receptor - The individual receiving the exposure in a given location or who ingests food products from a animal for example. A receptor can receive dose from one or more pathways.

Release Source(s) - A subsystem, tank, or vent where radioactive material can be released independently of other radioactive release points

STS - The St. Lucie - Unit 1 Standard Technical Specifications

μCi - micro-Curies. 1 μCi = 10^{-6} Curies. The μCi is the standard unit of radioactivity for all dose calculations in the ODCM.

$(\overline{X/Q})$ - a long term Chi over Q. It describes the physical dispersion characteristics of a semi-infinite cloud of noble gases as the cloud traverses downrange from the release point. Since Noble Gases are inert, they do not tend to settle out on the ground.

$(\overline{X/Q})_D$ - a long term Depleted Chi over Q. It describes the physical dispersion characteristics of a semi-infinite cloud of radioactive iodines and particulates as the cloud travels downrange. Since Iodines and particulates tend to settle out (fallout of the cloud) on the ground, the $(\overline{X/Q})_D$ represents what physically remains of the cloud and its dispersion qualities at a given location downrange from the release point.

1.0 LIQUID RELEASES

METHODOLOGY

1.1 Radioactive Liquid Effluent Model Assumptions

The FSAR contains the official description of the site characteristics. The description that follows is a brief summary for dose calculation purposes:

The St. Lucie Plant is located on an island surrounded on two sides by the Atlantic Ocean and the Indian River, an estuary of the Atlantic Ocean. Normally, all radioactive liquid releases enter the Atlantic Ocean where the Circulating Water Discharge Pipe terminates on the ocean floor at a point approximately 1200 feet offshore. No credit is taken for subsequent mixing of the discharge flume with the ocean. The diffusion of radioactive material into the ocean is dependent on the conditions of tide, wind, and some eddy currents caused by the Gulf Stream. The conditions are sufficiently random enough to distribute the discharges over a wide area and no concentrating effects are assumed.

There are no direct discharge paths for liquid effluents to either of the north or south private property boundary lines. The Big Mud Creek (part of the Indian River) does connect to a normally locked shut dam, that is intended to provide an emergency supply of circulating water to the Intake Cooling Water Canal in the event a Hurricane causes blockage of the Intake Canal. No radioactive water could be discharged directly into the Intake Cooling Water Canal because all plant piping is routed to the discharge canal and no back flow can occur. Consult the FSAR for a detailed description of characteristics of the water bodies surrounding the plant site.

Only those nuclides that appear in the Liquid Dose Factor Tables will be considered for dose calculation.

1.2 Determining the Fraction F of 10CFR20 MPC Limits for A Liquid Release Source

Discussion - Technical Specification 3.11.1.1 requires that the sampling and analysis results of liquid waste (prior to discharge) be used with calculation methods in the in-plant procedures to assure that the concentration of liquid radioactive material in the unrestricted areas will not exceed the concentrations specified in 10 CFR 20, Appendix B, Table II. This section presents the calculation method to be used for this determination. This method only addresses the calculation for a specific release source. The in-plant procedures will provide instructions for determining that the summation of each release source's F values do not exceed the site's 10 CFR 20 MPC limit. The values for release rate, dilution rate, etc will also have to be obtained from in-plant procedures. The basic equation is:

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(MPC)_i}$$

1.2 (cont)

Where:

F_L = the fraction of 10CFR20 MPC that would result if the release source was discharged under the conditions specified.

R = The undiluted release rate in gpm of the release source.

D = The dilution flow in gpm of Intake Cooling Water or Circulating Water Pumps

C_i = The undiluted concentration of nuclide (i) in µCi/ml from sample assay.

$(MPC)_i$ = The maximum permissible concentration of nuclide (i) in µCi/ml from Table L-1. For dissolved or entrained noble gases the MPC value is 2×10^{-4} µCi/ml for the sum of all gases.

The fraction of the 10 CFR 20 MPC limit may be determined by a nuclide-by-nuclide evaluation or for purposes of simplifying the calculation by a cumulative activity evaluation. If the simplified method is used, the value of 3×10^{-8} µCi/ml (unidentified MPC value) should be substituted for $(MPC)_i$ and the cumulative concentration (sum of all identified radionuclide concentrations) or the gross [illegible] concentration should be substituted for C_i. As long as the diluted concentration ($C_{total} \cdot \frac{R}{D}$) is less than 3×10^{-8} µCi/ml, the nuclide-by-nuclide calculation is not required to demonstrate compliance with the 10 CFR 20 MPC limit. The following section provides a step-by-step procedure for determining the MPC fraction.

1.2.1 Calculation Process for Solids

1.2.1.1 Obtain from the in-plant procedures, the release rate value (R) in gpm for the release source.

1.2.1.2 Obtain from the in-plant procedures, the dilution rate (D) in gpm. No credit is taken for any dilution beyond the discharge canal flow.

1.2.1.3 Obtain (C_i), the undiluted assay value of nuclide (i), in µCi/ml. If the simplified method is used, the cumulative concentration (C_{total}) is used.

1.2.1.4 From Table L-1, obtain the corresponding (MPC) for nuclide (i) in µCi/ml. The value of 3×10^{-8} µCi/ml should be used for the simplified method.

1.2.1.5 Divide C_i by (MPC)i and write down the quotient.

1.2 (cont)

1.2.1 (cont)

1.2.1.6 If the simplified method is used, proceed to the next step. If determining the MPC fraction by the nuclide-by-nuclide evaluation, repeat steps 1.2.1.3 through 1.2.1.5 for each nuclide reported in the assay.

1.2.1.7 Add each $C_i/(MPC)_i$ quotient from step 1.2.1.5 and solve for F

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(MPC)_i}$$

F_L = a unit-less value where:

The value of F_L could be ≤ 1 or >1. The purpose of the calculation is to determine what the initial value of F_L is for a given set of release conditions. If F_L is >1, administrative steps are taken to ensure that the actual release conditions for dilution will ensure that F_L is ≤ 1 during the actual release. F_L is called the fraction of 10CFR20 MPC because it should never be allowed to be >1.

1.2.2 Calculation Process for Gases in Liquid

1.2.1.1 Sum the uCi/ml of each noble gas activity reported in the release.

1.2.1.2 The values of R and D from 1.2.1 above shall be used in the calculations below:

$$F_g = \frac{(\text{sum of } 1.2.1.1)\ \text{uCi/ml}}{1} \times \frac{R}{D}$$

1.2.1.3 F_g shall be less than 2×10^{-4} uCi/ml for the site for all releases in progress. Each release point will be admininstratively controlled. Consult in-plant procedures for instructions.

1.3 Determining Setpoints for Radioactive Liquid Effluent Monitors

Discussion - Technical Specification 3.3.3.8 requires that the liquid effluent monitoring instrumentation alarm/trip setpoints be set to initiate an alarm or trip so that the radioactivity concentration in water in the unrestricted area does not exceed the concentration of 10 CFR 20, Appendix B, Table II as a result of radioactivity in liquid effluents. (Technical Specification 3.11.1.1). This section presents the method to be used for determining the instrumentation setpoints.

Gross cpm vs total liquid activity curves are available for Liquid Effluent Monitors based on a composite of real release data. A direct correlation between gross cpm and the concentrations that would achieve 10 CFR 20 MPC levels in the discharge canal can be estimated. The 1978 liquid release data from semiannual reports was used to determine the average undiluted release concentration. These concentrations were then projected to a diluted concentration in the discharge canal assuming a 1 gpm release rate and a constant dilution flow of 121,000 gpm from 1 circ water pump. This diluted activity was divided by the nuclide's respective 10CFR20 MPC value (Table L-1) to obtain the Mi column on the table that follows.

Table 1.3

NUCLIDE SYMBOL	1978 UNDILUTED µCi/ml[1]	M_i[2] (no units)
I-131	4.43 E-5	1.22 E-3
I-132	2.23 E-7	2.30 E-7
I-133	3.17 E-6	2.62 E-5
I-135	1.31 E-6	2.71 E-6
Na-24	1.72 E-7	4.74 E-8
Cr-51	2.51 E-5	1.04 E-7
Mn-54	5.64 E-6	4.66 E-7
Mn-56	1.11 E-9	9.17 E-11
Co-57	3.69 E-7	7.62 E-9
Co-58	1.51 E-4	1.39 E-5
Fe-59	2.92 E-6	4.83 E-7

Table 1.3 (cont)

NUCLIDE SYMBOL	1978 UNDILUTED µCi/ml	M_i (no units)
Co-60	3.66 E-5	1.00 E-5
Zn-65	4.55 E-7	3.76 E-8
Ni-65	8.23 E-7	6.80 E-8
Ag-110m	1.96 E-6	5.40 E-7
Sn-113	5.75 E-7	5.94 E-8
Sb-122	2.16 E-6	5.95 E-7
Sb-124	8.40 E-6	3.47 E-6
W-187	3.51 E-6	4.83 E-7
Np-239	1.57 E-7	1.30 E-8
Br-82	3.64 E-7	7.52 E-8
Zr-95	2.82 E-5	3.88 E-6
Zr-97	4.05 E-6	1.67 E-6
Mo-99	3.24 E-6	6.70 E-7
Ru-103	3.84 E-8	4.00 E-9
Sb-125	2.26 E-6	1.87 E-7
Cs-134	2.14 E-5	1.96 E-5
Cs-136	7.82 E-7	1.08 E-7
Cs-137	4.85 E-5	2.00 E-5
Ba-140	6.44 E-7	2.66 E-8
Ce-141	3.04 E-8	2.80 E-9
Ce-144	2.37 E-6	1.96 E-6
A_{tot} =	4.01 E-4	X
M_{Total} =		1.33 E-3

(1) 1978 Undiluted Release Volume = 7 E 9 mls.

(2) $M_i = \frac{\text{1978 Undil. Act Nuclide (i)}}{MPC_i \text{ (from Table L-1)}} \times \frac{\text{1 gpm (release rate)}}{\text{121000 gpm (dil rate)}}$

1.3 (cont)

A_{Tot} is the total average µCi/ml concentration of the reference mixture and M_{Tot} is the fraction of the MPC of all nuclides for the release conditions specified. Dividing A_{Tot} by M_{Tot} yields A_{Max}, which is the maximum total activity concentration equivalent to the MPC limit for the nuclide distribution typical of radwaste discharges.

$$A_{Max} = \frac{A_{Tot}}{M_{Tot}} = \frac{4.01\ E-4}{1.33\ E-3} = 0.302\ \mu Ci/ml$$

The assumption that the mixture does not change is only used for calculational purposes.

1.3.1 The (C_{max}) value in cpm should be obtained for the A_{max} (0.302 µCi/ml) from the release source's radioactive liquid effluent monitor curve of cpm vs µCi/ml.

NOTE: This setpoint is for a specified release of 1 gpm into 121000 gpm dilution flow.

1.3.2 For establishing the setpoint prior to liquid radwaste discharges, the (C_{max}) will be adjusted as needed to account for actual release conditions (ie, actual liquid discharge flow rate and dilution flow).

1.4 Determining the Dose for Radioactive Liquid Releases

Discussion - Technical Specification 3.11.1.2 requires calculations be performed at least once per 31 days to verify that cumulative radioactive liquid effluents do not cause a dose in excess of 1.5 mrem to the total body and 5 mrem to any organ. This section presents the calculational method to be used for this verification.

The method is based on the methodology suggested by sections 4.3 and 4.3.1 of NUREG-0133 Rev 1 Nov 1978. The dose factors are a composite of both the fish and shellfish pathways so that the fish-shellfish pathway is the only pathway for which dose will be calculated. For St. Lucie Unit 1, the adult is the most limiting age group, but the dose for child, and teenager can also be calculated by this method provided that their appropriate dose factors are available for the organ of interest. Only those nuclides that appear in the Tables of this manual will be considered.

1.4 (cont)

1.4.1 This method provides for a dose calculation to the total body or any organ for a given age group based on real release conditions during a specified time interval for radioactive liquid release sources. The equation is

$$D_{l\tau} = \frac{A_{i\tau}\,\Delta t_l\,Q_{il}}{(DF)_l}$$

where:

D_l = dose commitment in mrem received by organ τ of age group (to be specified) during the release time interval Δt_l.

$A_{i\tau}$ = the composite dose factor for the fish-shellfish pathway for nuclide (i) for organ τ of age group (to be specified). The $A_{i\tau}$ values listed in the Tables in this manual are independent of any site specific information and have the units $\frac{\text{mrem-ml}}{\mu\text{Ci-hr}}$

Δt_l = the number of hours that the release occurs.

Q_{il} = The total quantity of nuclide (i) released during Δt_l (µCi)

$(DF)_l$ = The total volume of dilution that occurred during the release time period Δt_l (ie, the circulating water flow times time)

The doses associated with each release may then be summed to provide the cumulative dose over a desired time period (eg sum all doses for release during a 31 day period, calander quarter or a year).

$$D_{total\,\tau} = \sum D_{l\tau}$$

where:

$D_{T\tau}$ = the total dose commitment to organ τ due to all releases during the desired time interval (mrem)

1.4 (cont)

1.4.1 (cont)

Based on the radionuclide distribution typical in radioactive effluents, the calculated doses to individuals are dominated by the radionuclides, Fe-59, Co-58, Co-60, Zn-65, Nb-95, Cs-134 and Cs-137. These nuclides typically contribute over 95% of the total body dose and over 90% of the GI-LLI dose, which is the critical organ. Therefore, the dose commitment due to radioactivity in liquid effluents may be reasonably evaluated by limiting the dose calculation process to these radionuclides for the adult total body and adult GI-LLI. To allow for any unexpected variability in the radionuclide distribution, a conservatism factor of 0.8 is introduced into the equation. After calculating the dose based on these 7 nuclides, the cumulative dose should be divided by 0.8, the conservatism factor. (ie, $D_\gamma = \frac{D_T}{0.8}$). Refer to Appendix B for a detailed evaluation and explanation of this limited analysis approach.

The methodology that follows is a step-by-step breakdown to calculate doses based on the above equation. Refer to the in-plant procedures to determine the applicable organs, age groups, and pathway factors. If the limited analysis approach is used, the calculation should be limited to the Adult total body dose and Adult GI-LLI dose from the fish and shellfish pathways. Only the 7 previously specified radionuclides should be evaluated. For the dose calculations to be included in semi-annual reports, the doses to all age groups and all organs should be evaluated for all radionuclides identified in the liquid effluents.

NOTE: Table 1.4 provides a convenient form for compiling the dose accounting.

1.4.1.1 Determine the time interval Δt_ℓ that the release took place. The in-plant procedures shall describe the procedure for calculating Δt_ℓ for official release purposes.

1.4.1.2 Obtain $(DF)_\ell$ for the time period Δt_ℓ from Liquid Waste Management Records for the release source(s) of interest.

1.4.1.3 Obtain $Q_{i\ell}$ for nuclide (i) for the time period Δt_ℓ from the Liquid Waste Management Records.

1.4.1.4 Obtain $A_{i\tau}$ from the appropriate Liquid Dose Factor Table.

TABLE 1.4

FISH & SHELLFISH PATHWAY

TIME/DATE START: ____________ TIME/DATE STOP: ____________ hours

TOTAL DILUTION VOLUME: ____________ mls

AGE GROUP: ____________ ORGAN: ____________ DOSE FACTOR TABLE # ________

Limited Analysis

Nuclide (i)	C_i (μCi)	$A_{i\tau}$	Dose (i) mrem
Fe-59			
Co-58			
Co-60			
Zn-65			
Nb-95			
Cs-134			
Cs-137			
Others:			

Total Dose $_\tau$ = ____________ mrem

If based on limited analysis ÷ 0.8 ____________ mrem

1.4 (cont)

1.4.1 (cont)

1.4.1.5 Solve for Dose (i)

$$\text{Dose (i)} = \frac{Q_{i1} \Delta t_1 A_{i\tau}}{(DF)_1}$$

1.4.1.6 Repeat steps 1.4.1.3 through 1.4.1.5 for each nuclide reported and each organ required. If the limited analysis method is used, limit the radionuclides to Fe-59, Co-58, Co-60, Zn-65, Nb-95, Cs-134, and Cs-137 and determine the adult total body dose and the adult GI-LLI dose.

1.4.1.7 Sum the Dose (i) values to obtain the total dose to organ τ from the fish-shellfish pathway. If the limited analysis method is being used, divide the cumulative dose by a conservatism factor of 0.8 to account for any unexpected variability in radionuclide distribution.

1.5 Projecting Dose for Radioactive Liquid Effluents

Discussion - Technical Specification 3.11.1.3 requires that appropriate subsystems of the liquid radwaste treatment system be used to reduce radioactive material in liquid effluents when the projected monthly dose due to liquid releases to unrestricted areas when averaged over 31 days would exceed 0.12 mrem to the total body or 0.4 mrem to any organ. Doses are to be projected at least once per 31 days. The following calculation method is provided for performing this dose projection. The method is based on dose as calculated in section 1.4 with the adult as the bases for projecting.

1.5.1 Obtain the latest result of the monthly calculation of the adult total body dose and the adult's highest organ dose. These doses can be obtained from the in-plant logs.

1.5.2 Divide each dose by the number of days the reactor plant was operational during the month.

1.5.3 Multiply the quotient of each dose by the number of days the reactor plant is projected to be operational during the next month. The products are the projected dose for the next month. These values should be adjusted as needed to account for any changes in failed fuel or other identifiable operating conditions that could significantly alter the actual releases.

1.5.4 If the projected dose is greater than 0.12 mrem to the total body or greater than 0.4 mrem to the adults highest exposed organ, the appropriate subsystems of the liquid radwaste system shall be used to reduce the radioactivity levels prior to release.

2.0 GASEOUS RELEASES

METHODOLOGY

2.1 Gaseous Effluent Model Assumptions

Description of Site - (The FSAR contains the official description of the site characteristics. The description that follows is a brief summary for dose calculation purposes only). The St. Lucie Plant is located on an island surrounded on two sides by the Atlantic Ocean and the Indian River, an estuary of the Atlantic Ocean. Private property adjoins the plant site in the north and south directions. A meterological tower is located north of the plant near the site property line. There are 16 sectors, for dose calculation purposes, divided into 22.5^o each. The met tower is calibrated such that a zero degree bearing coincides with TRUE NORTH. A bearing of zero degrees dissects the north sector such that bearings of 348.75^o and 11.25^o define the boundaries of the north sector. The nearest distance to private property occurs in the north sector at approximately 0.97 miles. For ease of calculation, this 0.97 mile radius is assumed in all directions, although the real Unrestricted Area Boundary is defined in Figure 3.11-1 of the STS. Doses calculated over water areas do not apply to the STS LCO's or the annual report and may be listed as O.W. (over water) in lieu of performing calculations. The 0.97 mile range in the NW sector is O.W., but it was chosen as the worst sector for conservative dose calculations using the historical met data.

Historical Met Data - Met data, between September 1, 1976 and August 31, 1978, from the St. Lucie Met Tower was analyzed by Dames & Moore of Washington, D.C. The methodology used by Dames & Moore was consistant with methods suggested by Regulatory Guide 1.111 Rev 1. Recirculation correction factors were also calculated for the St. Lucie Site and are incorporated into the historical met tables (Tables M5, M6, and M7) in Appendix A of this manual.

Dose Calculations - Dose calculations for Technical Specification dose limits are normally calculated using historical met data and receptor location(s) which yield calculated doses no lower than the real location(s) experiencing the most exposure. Real met data factors are calculated and used in dose calculations for the Semiannual Reports.

Live met data and hour-by-hour dose calculations are beyond the scope of this manual. Historical information and conservative receptor locations etc., are only used for ease of STS LCO dose limit calculations. Dose calculations for STS dose limits may be performed using real met data, real receptor locations, and sector wind frequency distribution if desired. Any dose calculations performed with real data should note the source of the data in the annual report. Real met data reduction should be performed in accordance with Regulatory Guide 1.111 Rev 1 and should incorporate Recirculation Correction Factors from Table M-4 of this manual. The St. Lucie site uses the long term ground release model for all gaseous effluents. Only those radionuclides that appear in the gaseous effluent dose factor tables will be considered in any dose calculations. Land Census information will apply to the calendar year following the year that the census was taken in to avoid splitting quarters etc.

2.2 Determining the Total Body and Skin Dose Rates for Noble Gas Releases and Establishing Setpoints for Effluent Monitors

Discussion - Technical Specification 3.11.2.1 limits the instantaneous dose rate from noble gaseous in airborne releases to less than 500 mrem/yr—total body and less than 3000 mrem/yr—skin. Technical Specification 3.3.3.9 requires that the gaseous radioactive effluent monitoring instrumentation be operable with alarm/trip setpoints set to ensure that these dose rate limits are not exceeded. The results of the sampling and analysis program of Technical Specification Table 4.11-2 are used to demonstrate compliance with these limits.

The following calculation method is provided for determining the instantaneous dose rates to the total body and skin from noble gaseous in airborne releases. The alarm/trip setpoints are based on the dose rate calculations. The Technical Specification LCOs apply to all airborne releases on the site but all releases may be treated as if discharged from a single release point. Only those noble gases appearing in Table G-2 will be considered. The calculation methods are based on Sections 5.1 and 5.2 of NUREG-0133, Nov 1978.

The equations are:

For Total Body Dose Rate

$$DR_{TB} = \sum_{i}^{n} K_i \, (\overline{X/Q}) \, \dot{Q}_i$$

For Skin Dose Rate

$$DR_{skin} = \sum_{i}^{n} \left[L_i + 1.1\, M_i \right] (\overline{X/Q}) \, \dot{Q}_i$$

where:

DR_{TB} = total body dose rate from noble gases in airborne releases (mrem/yr)

DR_{skin} = skin dose rate from noble gases in airborne releases (mrem/yr)

$\sum_{i}^{n}$ = a mathematical symbol to signify the operations to the right of the symbol are to be performed for each noble gas nuclide (i) through (n), and the individual nuclide doses are summed to arrive at the total dose rate for the release source.

K_i = the total body dose factor due to gamma emissions for each noble gas nuclide reported in the release source $\left(\frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}\right)$

2.2 (cont)

L_i = The skin dose factor due to beta emissions for each noble gas nuclide (i) reported in the assay of the release source $\left(\frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}\right)$

M_i = The air dose factor due to gamma emissions for each noble gas nuclide (i) reported in the assay of the release source. The constant 1.1 converts mrad to mrem since the units of M_i are in $\left(\frac{mrad\text{-}m^3}{\mu Ci\text{-}yr}\right)$

$(\overline{X/Q})$ = For ground level, the highest calculated annual long term historic relative concentration for any of the 16 sectors, at or beyond the exclusion area boundary. (sec/m^3).

$\dot{Q}_i$ = The release rate of noble gas nuclide (i) in μCi/sec from the release source of interest.

2.2.1 Simplified Total Body Dose Rate Calculation

From an evaluation of past releases, an effective total body dose factor (K_{eff}) can be derived. This dose factor is in effect a weighted average total body dose factor, ie, weighted by the radionuclide distribution typical of past operation. (Refer to Appendix C for a detailed explanation and evaluation of K_{eff}). The value of K_{eff} has been derived from the radioactive noble gas effluents for the years 1978, 1979, and 1980. The value is

$$K_{eff} = 6.8 \times 10^2 \quad \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}$$

This value may be used in conjunction with the total noble gas release rate ($\sum Qi$) to verify that the instantaneous dose rate is within the allowable limits. To allow for any unexpected variability in the radionuclide distribution, a conservatism factor of 0.8 is introduced into the calculation. The simplified equation is

$$DR_{TB} = \frac{K_{eff}\,(\overline{X/Q})}{0.8} \sum_i \dot{Q}_i$$

2.2 (cont)

2.2.1 (cont)

To further simplify the determination, the historical annual average meteorological X/Q of 1.6×10^{-6} sec/m^3 (from Table M-1) may be substituted into the equation. Also, the dose limit of 500 mrem/yr may be substituted for DR_{TB}. Making these substitutions yields a single cumulative (or gross) noble gas release rate limit. This value is

$$\text{Noble gas release rate limit} = 3.5 \times 10^{5}\ \mu Ci/sec$$

As long as the noble gas release rates do not exceed this value (3.5×10^{5} µCi/sec), no additional dose rate calculations are needed to verify compliance with Technical Specification 3.11.2.1.

2.2.2 Setpoint Determination

To comply with Technical Specification 3.3.3.9, the alarm/trip setpoints are established to ensure that the noble gas releases do not exceed the value of 6.5×10^{5} µCi/sec, which corresponds to a total body dose rate of 500 mrem/yr. The method that follows is a step-by-step procedure for establishing the setpoints. To allow for multiple sources of releases from different or common release points, the allowable operating setpoints be controlled administratively by allocating a percentage of the total allowable release to each of the release sources.

2.2.2.1 Determine (V) the maximum volume release rate potential from the in-plant procedures for the release source under consideration. The units of (V) are ft^3/min.

2.2.2.2 Solve for A, the activity concentration in µCi/cc that would produce the Y dose rate LCO

$$A = \frac{3.5 \times 10^{5}\ \mu Ci}{sec} \times \frac{min}{(V)\ ft3} \times \frac{ft^3}{2.8 \times 10^{4}\ cc} \times \frac{60\ sec}{min}$$

A = µCi/cc

2.2.2.3 Refer to the µCi/cc vs cpm curve for the Release Source's Gaseous Effluent Monitor cpm value (C), corresponding to the value of A above.

2.2.2.4 C is the 100% setpoint, assuming that there are no other release sources on the site.

2.2 (cont)

2.2.2 (cont)

2.2.2.5 Obtain the current % allocated to this release source from the gaseous waste management logs.

2.2.2.6 The Operating setpoint SP

$$SP = (C)\ cpm \times \frac{\%\ allotted\ by\ in\text{-}plant\ procedures}{100\%}$$

The total body dose is more limiting than the calculated skin dose. (Refer to Appendix C for a detailed evaluation.) Therefore, the skin dose rate calculations are not required if the simplified dose rate calculation is used (ie, use of Keff to determine release rate limits).

The calculation process of the following Section (2.2.3) are to be used if actual releases of noble gases exceed the above limit of 3.5×10^5 µCi/sec.

Under these conditions, a nuclide-by-nuclide evaluation is required to evaluate compliance with the dose rate limits of Technical Specification 3.11.2.1.

2.2.3 Total Body and Skin Nuclide Specific Dose Rate Calculations

The following outline provides a step-by-step explanation of how the total body dose rate is calculated on a nuclide-by-nuclide bases to evaluate compliance with Technical Specification 3.11.2.1. This method is only used if the actual releases exceed the value of 3.5×10^5 µCi/sec.

2.2.3.1 The $(\overline{X/Q})$ value = ______ sec/m^3 and _______ is the most limiting sector at the exclusion area.

2.2.3.2 Enter the release rate in ft^3/min of the release source and convert it to

$$= \frac{(\qquad)ft^3}{min} \times \frac{2.8317 \times 10^4 cc}{ft3} \times \frac{min}{60\ sec}$$

= cc/sec volume release rate

2.2.3.3 Solve for $\dot{Q}_i$ for nuclide (i) by obtaining the µCi/cc assay value of the release source and multiplying it by the product of 2.4.2 above

$$\dot{Q}_i = \frac{(nuclide(i))\ (assay)\quad \mu Ci}{cc} \times \frac{(\ 2.4.2\ value)\ cc}{sec}$$

$\dot{Q}_i$ = µCi/sec for nuclide (i)

2.2 (cont)

2.2.3 (cont)

2.2.3.4 To evaluate the total body dose rate obtain the K_i value for nuclide (i) from Table G-2.

2.2.3.5 Solve for DR_{TBi}

$$DR_{TBi} = K_i(\overline{X/Q})Q_i = \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr} \times \frac{sec}{m3} \times \frac{\mu Ci}{sec}$$

DR_{TBi} = $\frac{mrem}{yr}$ total body dose from nuclide (i) for the specified release source

2.2.3.6 To evaluate the skin dose rate obtain the L_i and M_i values from Table G-2 for nuclide (i).

2.2.3.7 Solve for $DR_{skin\ i}$

$$DR_{skin\ i} = \left[L_i + 1.1\ M_i\right] (\overline{X/Q})\ Q_i$$

$DR_{skin\ i}$ = $\frac{mrem}{yr}$ skin dose from nuclide (i) for the specified release source

2.2.3.8 Repeat steps 2.2.3.4 through 2.2.3.7 for each noble gas nuclide (i) reported in the assay of the release source.

2.2.3.9 The Dose Rate to the Total Body from radioactive noble gas gamma radiation from the specified release source is

$$DR_{TB} = \sum_{i}^{n} DR_{TBi}$$

2.2.3.10 The Dose Rate to the Skin from noble gas radiation from the specified release source is

$$DR_{skin} = \sum_{i}^{n} DR_{skin\ i}$$

The dose rate contribution of this release source shall be added to all other gaseous release sources that are in progress at the time of interest. Refer to in-plant procedures and logs to determine the Total Dose Rate to the Total Body and Skin from noble gas effluents.

2.3 Determining the Radioiodine & Particulate Dose Rate To Any Organ From Instantaneous Gaseous Releases

Discussion - Technical Specification 3.11.2.1 limits the dose rate from radioiodines and particulates with half lives greater than eight days to $\leq$ 1500 mrem/yr to any organ. The following calculation method, is provided for determining the dose rate from radioiodines and particulates and is based on Section 5.2.1 and 5.2.1.1 through 5.2.1.3 in NUREG-0133, Nov 1978.. The Infant is the controlling age group in the inhalation, ground plane, and cow/goat milk pathways, which are the only pathways considered for instantaneous releases. The long term $(\overline{X/Q})_D$ (depleted) and $(\overline{D/Q})$ values are based on historical met data prior to implementing Appendix I. Only those nuclides that appear on Table G-5 will be considered. The equations are

For Inhalation Pathway (excluding H-3):

$$DR_{I\&8DP_\tau} = \sum_i^n R_{i_\tau} \left(\overline{X/Q}\right)_D \dot{Q}_i$$

For Ground Plane:

$$DR_{I\&8DP_\tau} = \sum_i^n P_{i_\tau} \left(\overline{D/Q}\right) \dot{Q}_i$$

For Grass-Cow/Goat-Milk:

$$DR_{I\&8DP} = \sum_i^n R_{i_\tau} \left(\overline{D/Q}\right) \dot{Q}_i$$

For Tritium Releases (Inhalation & Grass-Cow/Goat-Milk):

$$DR_{H-3_\tau} = R_{H-3_\tau} \left(\overline{X/Q}\right)_D \dot{Q}_{H-3}$$

For Total Dose Rate from I & 8DP and H-3 To an Infant Organ τ:

$$DR_\tau = \sum_{z} \left[DR_{I\&8DP_\tau} + DR_{H-3_\tau} \right]$$

2.3 (cont)

where:

τ = The organ of interest for the infant age group.

z = The applicable pathways

$DR_{I\&8DP_\tau}$ = Dose Rate in mrem/yr to the organ τ from iodines and 8 day particulates

$DR_{H\text{-}3_\tau}$ = Dose Rate in mrem/yr to organ τ from Tritium

DR_τ = Total Dose Rate in mrem/yr to organ τ from all pathways under consideration

$\sum_i^n$ = A mathematical symbol to signify the operations to the right of the symbol are to be performed for each nuclide (i) through (n), and the individual nuclide dose rates are summed to arrive at the total dose rate from the pathway.

$\sum_z$ = A mathematical symbol to indicate that the total dose rate D_τ to organ τ is the sum of each of the pathways dose rates

R_i = The dose factor for nuclide (i) for organ τ for the pathway specified (units vary by pathway).

P_i = The dose factor for instantaneous ground plane pathway in units of $\frac{mrem\text{-}m^2 sec}{\mu Ci\text{-}yr}$

From an evaluation of the radioactive releases and environmental pathways, the grass-cow/goat-milk pathway has been identified as the most limiting pathway with the infant's thyroid being the critical organ. This pathway typically contributes greater than 90% of the total dose received by the infant's thyroid and the radioiodine contribute essentially all of this dose. Therefore, it is possible to demonstrate compliance with the release rate limit of Technical Specification 3.11.2.1 for radioiodines and particulates by only evaluating the infant's thyroid dose for the release of radioiodines via the grass-cow/goat-milk pathway. The calculation method of Section 2.3.3 is used for this determination. If this limited analysis approach is used, the dose calculations for other radioactive particulate matter and other pathways need not be performed. Only the calculations of Section 2.3.3 for the radioiodines need be performed to demonstrate compliance with the Technical Specification dose rate limit.

2.3 (cont)

The calculations of Sections 2.3.1, 2.3.2, 2.3.4, and 2.3.5 may be omitted. The dose rate calculations as specified in these sections are included for completeness and are to be used only for evaluating unusual circumstances where releases of particulate materials other than radioiodines in airborne releases are abnormally high. The calculations of Sections 2.3.1, 2.3.2, 2.3.4, and 2.3.5 will typically be used to demonstrate compliance with the dose rate limit of Technical Specification 3.11.2.1 for radioiodines and particulates when the measured releases of particulate material (other than radioiodines and with half lives greater than eight days) are greater than ten (10) times the measured releases of radioiodines.

2.3.1 <u>The Instantaneous Inhalation Dose Rate Method</u>:

NOTE: The H-3 dose is calculated as per 2.3.4

2.3.1.1 The controlling location is assumed to be an Infant located in the _____ sector at the _____ mile range. The $(\overline{X/Q})_D$ for this locations is _________ sec/m^3. This value is common to all nuclides.

2.3.1.2 Enter the release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\_\_\_\_\_\_\ ft^3}{min} \times \frac{2.8317 \times 10^4 cc}{ft^3} \times \frac{min}{60\ sec} = \quad cc/sec$$

2.3.1.3 Solve for $\dot{Q}_i$ for nuclide(i) by obtaining the µCi/cc assay value of the release source activity and multiplying it by the product of 2.3.1.2 above.

$$\dot{Q}_i = \frac{(nuclide(i)assay)\mu Ci}{cc} \times \frac{(Value\ 2.5.1.2)\ \ cc}{sec}$$

$\dot{Q}_i =$ µCi/sec for nuclide(i)

2.3.1.4 Obtain the R_i value from Table G-5 for the organ τ.

2.3 (cont)

2.3.1 (cont)

2.3.1.5 Solve for DR_i

$$DR_{i\tau} = R_{i\tau} (\overline{X/Q})_D \dot{Q}_i = \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr} \times \frac{sec}{m^3} \times \frac{\mu Ci}{sec}$$

$DR_{i\tau} = \frac{mrem}{yr}$ the Dose Rate to organ τ from nuclide(i)

2.3.1.6 Repeat steps 2.3.1.3 through 2.3.1.5 for each nuclide(i) reported in the assay of the release source.

2.3.1.7 The Instantaneous Dose Rate to the Infants organ τ from the Inhalation Pathway is

$$DR_{Inhalation_\tau} = DR_1 + DR_2 + \text{---} + DR_n$$

for all nuclides except H-3. This dose rate shall be added to the other pathways as per 2.3.5 - Total Organ Dose.

NOTE: Steps 2.3.1.3 through 2.3.1.7 need to be completed for each organ τ of the Infant.

2.3.2 <u>The Instantaneous Ground Plane Dose Rate Method</u>:

NOTE: Tritium dose via the ground plane is zero.

2.3.2.1 The controlling location is assumed to be an Infant located in the _____ sector at the _____ range. The $(\overline{D/Q})$ for this location is _________ $1/m^2$. This value is common to all nuclides.

2.3.2.2 Enter the release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\_\_\_\_\_\_\_\_\_\_ ft^3}{min} \times \frac{2.8317 \times 10^4 cc}{ft^3} \times \frac{min}{60 sec} = cc/sec$$

2.3 (cont)

2.3.2 (cont)

2.3.2.3 Solve for $\dot{Q}_i$ for nuclide(i) by obtaining the µCi/cc assay value from the release source activity and multiplying it by the product of 2.3.2.2 above.

$$\dot{Q}_i = \frac{(\text{nuclide(i)assay})\mu Ci}{cc} \times \frac{(\text{Value 2.3.2.2})cc}{sec}$$

$$\dot{Q}_i = \qquad \mu Ci/sec \text{ for nuclide(i)}$$

2.3.2.4 Obtain the P_i value from Table G-3

2.3.2.5 Solve for DR_i

$$DR_i = P_{i\tau}(\overline{D/Q})\ \dot{Q}_i = \frac{mrem\text{-}m^2\text{-}sec}{\mu Ci\text{-}yr} \times \frac{1}{m^2} \times \frac{\mu Ci}{sec}$$

$DR_i = \qquad \frac{mrem}{yr}$ the Dose Rate to organ τ from nuclide(i)

2.3.2.6 Repeat steps 2.3.2.3 through 2.3.2.5 for each nuclide(i) reported in the assay of the release source.

2.3.2.7 The Instantaneous Dose Rate to the Infant's Total body from the Ground Plane Pathway is

$$DR_{Gr\ Pl} = DR_1 + DR_2 + --- + DR_n$$

for all nuclides. This dose rate shall be added to the other pathways as per 2.3.5

2.3 (cont)

2.3.3 The Instantaneous Grass-Cow/Goat-Milk Dose Rate Method:

NOTE: H-3 dose is calculated as per 2.3.4

2.3.3.1 The controlling animal was established as a ________ located in the ________ sector at ________ miles. The $(\overline{D/Q})$ for this location is ________ $1/m^2$. This value is common to all nuclides.

2.3.3.2 Enter the anticipated release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\_\_\_\_\_\_\_ ft^3}{min} \times \frac{2.8317 \times 10^4 cc}{ft^3} \times \frac{min}{60 sec} = \quad cc/sec$$

2.3.3.3 Solve for $\dot{Q}_i$ for nuclide(i) by obtaining the μCi/cc assay value of the release source activity and multiplying it by the product of 2.3.3.2 above.

$$\dot{Q}_i = \frac{(nuclide(i)assay)\mu Ci}{cc} \times \frac{(value\ 2.3.3.2)cc}{sec}$$

$$\dot{Q}_i = \qquad \mu Ci/sec \text{ for nuclide(i)}$$

2.3.3.4 Obtain the R_i value from Table G-6(7) (whichever is the controlling animal, goat/cow, for infant).

If the limited analysis approach is being used, limit the calculation to the infant thyroid.

2.3.3.5 Solve for $DR_{i\tau}$

$$DR_{i\tau} = R_{i\tau} \ (\overline{D/Q}) \ \dot{Q}_i = \frac{mrem\text{-}m^2\text{-}sec}{\mu Ci\text{-}yr} \times \frac{1}{m^2} \times \frac{\mu Ci}{sec}$$

$DR_{i\tau}$ = mrem/yr the Dose Rate to organ τ from nuclide(i)

2.3.3.6 Repeat steps 2.3.3.3 through 2.3.3.5 for each nuclide(i) reported in the assay of the release source.

Only the radioiodines need to be included if the limited analysis approach is being used.

2.3 (cont)

2.3.3 (cont)

2.3.3.7 The Instantaneous Dose Rate to the Infant's organ τ from Grass-______-Milk pathway is

$$DR_{Grass-\_\_\_\_-Milk_{\tau}} = DR_1 + DR_2 + --- + DR_n$$

for all nuclides. This dose rate shall be added to the other pathways as per 2.3.5 - Total Organ dose.

NOTE: Steps 2.3.3.3 through 2.3.3.7 need to be completed for each organ of the Infant. Limit the calculation to the infant thyroid if the limited analysis approach is being used.

2.3.4 The Instantaneous H-3 Dose Rate Method:

2.3.4.1 The controlling locations and their $(\overline{X/Q})_D$ values for each pathway are:

Inhalation - Infant at _______ range in the _______ sector. $(\overline{X/Q})_D$ = sec/m^3

Ground Plane - Does not apply to H-3.

Grass-Cow/Goat-Milk - _________ located in the ______ sector at _______ miles with an Infant at the exclusion area in the ______ sector drinking the milk. The $(\overline{X/Q})_D$ for the _______ location is $(\overline{X/Q})_D$ = _________ sec/m^3.

2.3.4.2 Enter the anticipated release rate in ft^3/ min of the release source and convert it to cc/sec

$$= \frac{\_\_\_\_\_\_\_\_ ft^3}{min} \times \frac{2.8317 \times 10^4 cc}{ft^3} \times \frac{min}{sec}$$

= cc/sec volume release rate

2.3 (cont)

2.3.4 (cont)

2.3.4.3 Solve for $\dot{Q}_{H-3}$ for Tritium, by obtaining the μCi/cc assay value of the release source, and multiplying it by the product of 2.3.4.2 above

$$\dot{Q}_{H-3} = \frac{(H\text{-}3)\mu Ci}{cc} \times \frac{(2.3.4.2 \text{ value})cc}{sec}$$

$\dot{Q}_{H-3}$ = μCi/sec activity release rate

2.3.4.4 Obtain the Tritium dose factor (R_i) for Infant organ τ from

Path	Table #
Inhalation	G-5
Grass- -Milk	G-6(7)

2.3.4.5 Solve for $D_{H-3\tau}$ (Inhalation) using the $(\overline{X/Q})_D$ for inhalation from 2.3.4.1 and R_{H-3} (Inhalation) from 2.3.4.4

$$DR_{H\text{-}3\,Inh_\tau} = R_{H\text{-}3\,Inh_\tau} \; (\overline{X/Q})_D \; \dot{Q}_{H-3}$$

$DR_{H\text{-}3\,Inh_\tau}$ = mrem/yr from H-3 Infant Instantaneous Inhalation for organ τ

2.3.4.6 Solve for D_{H-3} (Grass- -Milk) using the $(\overline{X/Q})_D$ for Grass- -Milk from 2.3.4.1 and

R_{H-3} (Grass- -Milk) from 2.3.4.4

$$DR_{H\text{-}3\,G\text{-}\ \text{-}M_\tau} = R_{H\text{-}3\,G\text{-}\ \text{-}M_\tau} \; (\overline{X/Q})_D \; \dot{Q}_{H-3}$$

$DR_{H\text{-}3\,G\text{-}\ \text{-}M_\tau}$ = mrem/yr from H-3 Infant Instantaneous G- -Milk for organ τ

2.3 (cont)

2.3.4 (cont)

2.3.4.7 Repeat steps 2.3.4.4 through 2.3.4.6 for each Infant organ τ of interest.

2.3.4.8 The individual organ dose rates from H-3 shall be added to the other organ pathway dose rates as per 2.3.5.

2.3.5 <u>Determining the Total Organ Dose Rate from Iodines, 8D-Particulates, and H-3 from Instantaneous Release Source(s)</u>

2.3.5.1 The following table describes all the pathways that must be summed to arrive at the total dose rate to an organ τ:.

Pathway	Dose Rate	Step # Ref
Inhalation(I&8DP)		2.3.1.7
Ground Pl.(I&8DP)	(T.Body only)	2.3.2.7
Gr- -Milk(I&8DP)		2.3.3.7
Inhalation (H-3)		2.3.4.5
Gr- -Milk(H-3)		2.3.4.6
DR_τ =	(sum of above)	

2.3.5.2 Repeat the above summation for each Infant organ τ.

2.3.5.3 The DR_τ above shall be added to all other release sources that will be in progress at any instant. Refer to in-plant procedures and logs to determine the Total DR_τ to each organ.

2.4 Determining the Gamma Air Dose for Radioactive Noble Gas Release Source(s)

Discussion - Technical Specification 3.11.2.2 limits the quarterly air dose due to noble gases in gaseous effluents to less than 5 mrads for gamma radiation. The following calculation method, is provided for determining the noble gas gamma air dose and is based on sections 5.3.1 of NUREG-0133, Nov 1978. The dose calculation is independent of any age group. The equation may be used for STS dose calculation, the dose calculation for the annual report or for projecting dose, provided that the appropriate value of $(\overline{X/Q})$ is used as outlined in the detailed explanation that follows. The equation for gamma air dose is

$$D_{\gamma\text{-air}} = \sum_{i}^{n} 3.17\times10^{-8}\, M_i (\overline{X/Q})\, Q_i$$

where:

$D_{\gamma\text{-air}}$ = gamma air dose in mrad from radioactive noble gases.

$\sum_{i}^{n}$ = a mathematical symbol to signify the operations to the right side of the symbol are to be performed for each nuclide(i) through (n), and summed to arrive at the total dose, from all nuclides reported during the interval. No units apply.

3.17×10^{-8} = The inverse of the number of seconds per year with units of year/sec.

M_i = The gamma air dose factor for radioactive noble gas nuclide(i) in units of $\frac{\text{mrad-m}^3}{\mu\text{Ci-yr}}$.

$(\overline{X/Q})$ = The long term atmospheric dispersion factor for ground level releases in units of sec/m^3. The value of $(\overline{X/Q})$ is the same for all nuclides(i) in the dose calculation, but the value of $(\overline{X/Q})$ does vary depending on the Limiting Sector the L.C.O. is based on etc.

Q_i = The number of micro-curies of nuclide(i) released (or projected) during the dose calculation exposure period. (eg. month, quarter, or year)

2.4 (cont)

From an evaluation of past releases, a single effective gamma air dose factor (M_{eff}) has been derived, which is representative of the radionuclide abundances and corresponding dose contributions typical of past operation. (Refer to Appendix C for a detailed explanation and evaluation of M_{eff}.) The value of M_{eff} has been derived from the radioactive noble gas effluents for the years 1978, 1979, and 1980. The value is

$$M_{eff} = 7.4 \times 10^2 \frac{mrad/yr}{\mu Ci/m^3}$$

This value may be used in conjunction with the total noble gas releases ($\sum_i Q_i$) to simplify the dose evaluation and to verify that the cumulative gamma air dose is within the limits of Specification 3.11.2.2. To allow for any unexpected variability in the radionuclide distribution, a conservatism factor of 0.8 in introduced into the calculation. The simplified equation is

$$D_{\gamma\text{-air}} = \frac{3.17 \times 10^{-8}}{0.8} M_{eff} \overline{X/Q} \sum_i Q_i$$

For purposes of calculations, the appropriate meteorological dispersion ($\overline{X/Q}$) from Table M-1 should be used. Technical Specification 3.11.2.2 requires that the doses be evaluated once per 31 days, (ie, monthly). The quarterly dose limit is 5 mrads, which corresponds to a monthly allotment of 1.7 mrads. If the 1.7 mrads is substituted for D_{γ} - air, a cumulative noble gas monthly release objective can be calculated. This value is

64,000 Ci/month, noble gases.

As long as this value is not exceeded in any month, no additional calculations are needed to verify compliance with the quarterly noble gas release limits of Specification 3.11.2.2. Also, the gamma air dose is more limiting than the beta air dose. Therefore, the beta air dose does not need to be calculated per Section 2.5 if the M_{eff} dose factor is used to determine the gamma air dose. Refer to Appendix C for a detailed evaluation and explanation.

The calculations of Section 2.5 may be omitted when this limited analysis approach is used but should be performed if the radionuclide specific dose analysis is performed. Also, the radionuclide specific calculations will be performed for inclusion in semi-annual reports.

2.4 (cont)

The following steps provide a detailed explanation of how the radionuclide specific dose is calculated. This method is used to evaluate quarterly doses in accordance with Technical Specification 3.11.2.2 if the releases of noble gases during any month of the quarter exceed 64,000 Ci

2.4.1 To determine the applicable $(\overline{X/Q})$ refer to Table M-1 to obtain the value for the type of dose calculation being performed. ie Quarterly L.C.O. or Dose Projection for examples. This value of $(\overline{X/Q})$ applies to each nuclide(i).

2.4.2 Determine (M_i) the gamma air dose factor for nuclide(i) from Table G-2.

2.4.3 Obtain the micro-Curies of nuclide(i) from the in-plant radioactive gaseous waste management logs for the sources under consideration during the time interval.

2.4.4 Solve for D_i as follows:

$$D_i = \frac{3.17\text{x}10^{-8}\text{yr}}{\text{sec}} \times \frac{M_i \text{mrad-m}^3}{\mu\text{Ci-yr}} \times \frac{(\overline{X/Q})\text{sec}}{\text{m}^3} \times \frac{Q_i\ \mu\text{Ci}}{1}$$

D_i = mrad = the dose from nuclide(i)

2.4.5 Perform steps 2.4.2 through 2.4.4 for each nuclide(i) reported during the time interval in the source.

2.4.6 The total gamma air dose for the pathway is determined by summing the D_i dose of each nuclide(i) to obtain D_γ-air dose.

$$D_{\gamma\text{-air}} = D_1 + D_2 + \text{---} + D_n = \text{mrad}$$

NOTE: Compliance with a 1/31 day LCO, Quarterly LCO, yearly or 12 consecutive months LCO can be demonstrated by the limited analysis approach using M_{eff}. Using this method only requires that steps 2.4.2 through 2.4.5 be performed one time, remembering that the dose must be divided by 0.8, the conservatism factor.

2.4.7 Refer to in-plant procedures for comparing the calculated dose to any applicable limits that might apply.

2.5 Determining the Beta Air Dose for Radioactive Noble Gas Releases

Discussion - Technical Specification 3.11.2.2 limits the quarterly air dose due to beta radiation from noble gases in gaseous effluents to less than 10 mrads. The following calculation

2.5 (cont)

method is provided for determining the beta air dose and is based on Sections 5.3.1 of NUREG-0133, Nov 1978. The dose calculation is independent of any age group. The equation may be used for STS dose calculation, dose calculation for annual reports, or for projecting dose, provided that the appropriate value of $(\overline{X/Q})$ is used as outlined in the detailed explanation that follows.

The equation for beta air dose is

$$D_{\beta\text{-air}} = \sum_{i}^{n} 3.17 \times 10^{-8} N_i (\overline{X/Q}) Q_i$$

where:

$D_{\beta\text{-air}}$ = beta air dose in mrad from radioactive noble gases.

$\sum_{i}^{n}$ = a mathematical symbol to signify the operations to the right side of the symbol are to be performed for each nuclide(i) through (n), and summed to arrive at the total dose, from all nuclides reported during the interval. No units apply.

3.17×10^{-8} = The inverse of the number of seconds per year with units of year/sec.

N_i = The beta air dose factor for radioactive noble gas nuclide(i) in units of $\frac{\text{mrad-m}^3}{\mu\text{Ci-yr}}$.

$(\overline{X/Q})$ = The long term atmospheric dispersion factor for ground level releases in units of sec/m^3. The value of $(\overline{X/Q})$ is the same for all nuclides(i) in the dose calculation, but the value of $(\overline{X/Q})$ does vary depending on the Limiting Sector the LCO is based on etc.

Q_i = the number of micro-Curies of nuclide(i) released (or projected) during the dose calculation exposure period.

2.5 (cont)

The beta air dose does not have to be evaluated if the noble gas gamma air dose is evaluated by the use of the effective gamma air dose factor (M_{eff}). However, if the nuclide specific dose calculation is used to evaluate compliance with the quarterly gamma air dose limits (Section 2.4), the beta air dose should also be evaluated as outlined below for the purpose of evaluating compliance with the quarterly beta air dose limits of Technical Specification 3.11.2.2. The following steps provide a detailed explanation of how the dose is calculated.

2.5.1 To determine the applicable ($\overline{X/Q}$) refer to Table M-1 to obtain the value for the type of dose calculation being performed (ie Quarterly LCO or Dose Projection for examples). This value of ($\overline{X/Q}$) applies to each nuclide(i).

2.5.2 Determine (N_i) the beta air dose factor for nuclide(i) from Table G-2.

2.5.3 Obtain the micro-Curies of nuclide(i) from the in-plant radioactive gaseous waste management logs for the source under consideration during the time interval.

2.5.4 Solve for D_i as follows:

$$D_i = \frac{3.17\text{x}10^{-8}\text{yr}}{\text{sec}} \text{ x } \frac{N_i \text{ mrad-m}^3}{\mu\text{Ci-yr}} \text{ x } \frac{(\overline{X/Q})\text{sec}}{\text{m}^3} \text{ x } \frac{Q_i\mu\text{Ci}}{1}$$

D_i = mrad = the dose from nuclide(i)

2.5.5 Perform steps 2.5.2 through 2.5.4 for each nuclide (i) reported during the time interval in the release source.

2.5.6 The total beta air dose for the pathway is determined by summing the D_i dose of each nuclide(i) to obtain $D_{\beta\text{-air}}$ dose

$$D_{\beta\text{-air}} = D_1 + D_2 + \text{---} + D_n = \text{ mrad}$$

2.5.7 Refer to in-plant procedures for comparing the calculated dose to any applicable limits that might apply.

2.6 Determining the Radioiodine and Particulate Dose To Any Organ From Cumulative Releases

Discussion - Technical Body Specification 3.11.2.3 limits the dose to the total body or any organ resulting from the release of radioiodines and particulates with half-lives greater than 8 days to less than 7.5 mrem/quarter. The following calculation method is provided for determining the critical organ dose due to releases of radioiodines and particulates and is based on Section 5.3.1 of NUREG-0133 Nov 1978. The equation can be used for any age group provided that the appropriate dose factors are used and the total dose reflects only those pathways that are applicable to the age group. The $(\overline{X/Q})_D$ symbol represents a DEPLETED-$(\overline{X/Q})$ which is different from the Noble Gas $(\overline{X/Q})$ in that $(\overline{X/Q})_D$ takes into account the loss of I&8DP and H-3 from the plume as the semi-infinite cloud travels over a given distance. The $(\overline{D/Q})$ dispersion factor represents the rate of fallout from the cloud that affects a square meter of ground at various distances from the site. The I&8DP and H-3 notations refer to Radioiodine and Particulates having half-lives > 8 days, and Tritium. Tritium calculations are always based on $(\overline{X/Q})_D$. The first step is to calcluate the I&8DP and H-3 dose for each pathway that applies to a given age group. The total dose to an organ can then be determined by summing the pathways that apply to the receptor in the sector. The equations are:

For Inhalation Pathway (excluding H-3):

$$D_{I\&8DP_\tau} = \sum_{i}^{n} 3.17\text{x}10^{-8} R_i (\overline{X/Q})_D Q_i$$

For Ground Plane or Grass-Cow/Goat-Milk

$$D_{I\&8DP} = \sum_{i}^{n} 3.17\text{x}^{-8} R_i (\overline{D/Q}) Q_i$$

For each pathway above (excluding Ground Plane) for Tritium:

$$D_{H-3_\tau} = 3.17\text{x}10^{-8} R_i (\overline{X/Q})_D Q_i$$

For Total Dose from Particulate Gaseous effluent to organ τ of a specified age group:

$$D_\tau = \sum_{z} \left[D_{I\&8DP} + D_{H-3} \right]$$

2.6 (cont)

where:

τ = the organ of interest of a specified age group

z = the applicable pathways for the age group of interest

$D_{I\&8DP}$ = Dose in mrem to the organ τ of a specified age group from radioiodines and 8D Particulates.

D_{H-3} = Dose in mrem to the organ τ of a specified age group from Tritium.

D_{τ} = Total Dose in mrem to the organ τ of a specified age group from Gaseous Particulate Effluents.

$\sum_{i}^{n}$ = A mathematical symbol to signify the operations to the right of the symbol are to be performed for each nuclide(i) through (n), and the individual nuclide doses are summed to arrive at the total dose from the pathway of interest to ogran τ.

$\sum_{z}$ = A mathematical symbol to indicate that the total dose D_{τ} to organ τ is the sum of each of the pathway doses of I&8DP and H-3 from gaseous particulate effluents.

3.17×10^{-8} = The inverse of the number of seconds per year with units of year/sec.

R_i = The dose factor for nuclide(i) (or H-3) for pathway z to organ τ of the specified age group. The units are either $\frac{\text{mrem-m}^3}{\text{yr-}\mu\text{Ci}}$ for pathways using $(\overline{X/Q})_D$, or $\frac{\text{mrem-m}^2\text{-sec}}{\text{yr-}\mu\text{Ci}}$ for pathways using $(\overline{D/Q})$

$(\overline{X/Q})_D$ = The depleted-$(\overline{X/Q})$ value for a specific location where the receptor is located (see discussion). The units are sec/m^3.

$(\overline{D/Q})$ = The deposition value for a specific location where the receptor is located (see discussion). The units are $1/m^2$ where m = meters.

Q_i = The number of micro-Curies of nuclide(i) released (or projected) during the dose calculation exposure period.

Q_{H-3} = The number of micro-Curies of H-3 released (or projected) during the dose calculation exposure period.

2.6 (cont)

As discussed in Section 2.5, the grass-cow/goat-milk pathway has been identified as the most limiting pathway with the infant's thyroid being the critical organ. This pathway typically contributes greater than 90% of the total dose received by the infant's thyroid and the radioiodine contribute essentially all of this dose. Therefore, it is possible to demonstrate compliance with the dose limit of Technical Specification 3.11.2.3 for radioiodines and particulates by only evaluating the infant's thyroid dose due to the release of radioiodines via the grass-cow/goat-milk pathway. The calculation method of Section 2.6.3 is used for this determination. The dose determined by Section 2.6.3 should be divided by a conservatism factor of 0.8. This added conservatism provides assurance that the dose determined by this limited analysis approach will be less than the dose that would be determined by evaluating all radionuclides and all pathways. If this limited analysis approach is used, the dose calculations for other radioactive particulate matter and other pathways need not be performed. Only the calculations of Section 2.6.3 for the radioiodines are required to demonstrate compliance with the Technical Specification dose limit. However, for the dose assessment included in Semi Annual Reports, doses will be evaluated for all designated age groups and organs via all designated pathways from radioiodines and particulates measured in the gaseous effluents according to the sampling and analyses required in Technical Specification Table 4.11-2. The following steps provide a detailed explanation of how the dose is calculated for the given pathways:

2.6.1 <u>The Inhalation Dose Pathway Method</u>:

NOTE: The H-3 dose should be calculated as per 2.6.4.

2.6.1.1 Determine the applicable $(\overline{X/Q})_D$ from Table M-2 for the location where the receptor is located. This value is common to each nuclide(i).

2.6 (cont)

2.6.1 (cont)

2.6.1.2 Determine the R_i factor of nuclide(i) for the organ τ and age group from Table G-3.

2.6.1.3 Obtain the micro-Curies (Q_i) of nuclide (i) from the radioactive gas waste management logs for the release source(s) under consideration during the time interval.

2.6.1.4 Solve for D_i

$$D_i = 3.17 \times 10^{-8} Ri (\overline{X/Q})_D Q_i$$

D_i = mrem from nuclide(i)

2.6.1.5 Perform steps 2.6.1.2 through 2. .1.4 for each nuclide(i) reported during the time interval for each organ.

2.6.1.6 The Inhalation dose to organ τ of the specified age group is determined by summing the D_i Dose of each nuclide(i)

$$D_{\substack{\text{Inhalation}\\\text{(Age Group)}}} = D_1 + D_2 + \text{---} + D_n = \quad \text{mrem}$$

Refer to 2.6.5 to determine the total dose to organ τ from radioiodines & 8D Particulates.

2.6.2 The Ground Plane Dose Pathway Method:

NOTE: Tritium dose via the ground plane is zero. The Total Body is the only organ considered for the Ground Plane pathway dose.

2.6.2.1 Determine the applicable $(\overline{D/Q})$ from Table M-2 for the location where the receptor is located. This $(\overline{D/Q})$ value is common to each nuclide(i).

2.6.2.2 Determine the Ri factor of nuclide(i) for the total body from Table G-4. The ground plane pathway dose is the same for all age groups.

2.6.2.3 Obtain the micro-Curies (Q_i) of nuclide(i) from the radioactive gas waste management logs for the source under consideration.

2.6 (cont)

2.6.2 (cont)

2.6.2.4 Solve for D_i

$$D_i = 3.17 \times 10^{-8} R_i (\overline{D/Q}) Q_i$$

D_i = mrem for nuclide(i)

2.6.2.5 Perform steps 2.6.2.2 through 2.6.2.4 for each nuclide(i) reported during the time interval.

2.6.2.6 The Ground Plane dose to the total body is determined by summing the Di dose of each nuclide(i)

$$D_{Gr.Pl.-TBody} = D_1 + D_2 + --- + D_n = \qquad \text{mrem}$$

Refer to step 2.6.5 to calculate total organ dose.

2.6.3 <u>The Grass-Cow/Goat-Milk Dose Pathway Method</u>:

NOTE: Tritium does is calculated as per 2.6.4

2.6.3.1 A cow, or a goat, will be the controlling animal; ie. dose will not be the sum of each animal, as the human receptor is assumed to drink milk from only the most restrictive animal. Refer to Table M-3 to determine which animal is controlling based on its $(\overline{D/Q})$.

2.6.3.2 Determine the dose factor R_i for nuclide(i), for organ τ, from

2.6.3.2.1 From Table G-5 for a cow, or;

2.6.3.2.2 From Table G-6 for a goat.

If the limited analysis approach is being used, limit the calculation to the infant thyroid.

2.6.3.3 Obtain the micro-Curies (Q_i) of nuclide(i) from the radioactive gas waste management logs for the release source under consideration during the time interval.

2.6 (cont)

2.6.3 (cont)

2.6.3.4 Solve for D_i:

$$D_i = 3.17 \times 10^{-8} R_i (\overline{D/Q}) Q_i$$

D_i = mrem from nuclide(i)

2.6.3.5 Perform steps 2.6.3.2 through 2.6.3.4 for each nuclide(i) reported during the time interval. Only the radioiodines need to be included if the limited analysis approach is used.

2.6.3.6 The Grass-Cow-Milk (or Grass-Goat-Milk) pathway dose to organ τ is determined by summing the Di dose of each nuclide(i).

$$D_{G-C-M} \left(\text{or } D_{G-G-M}\right) = D_1 + D_2 + \text{---} + D_n = \quad \text{mrem}$$

The dose to each organ should be calculated in the same manner with steps 2.6.3.2 through 2.6.3.6. Refer to step 2.6.5 to determine the total dose to organ τ from radioiodines & 8D Particulates. If the limited analysis approach is being used the infant thyroid dose via the grass-cow(goat)-milk pathway is the only dose that needs to be determined. Section 2.6.5 can be omitted.

2.6.4 <u>The Gaseous Tritium Dose (Each Pathway) Method:</u>

2.6.4.1 The controlling locations for the pathway(s) has already been determined by:

Inhalation - as per 2.6.1.1
Ground Plane - not applicable for H-3
Grass-Cow/Goat-Milk - as per 2.6.3.1

2.6.4.2 Tritium dose calculations use the depleted $(\overline{X/Q})_D$ instead $(\overline{D/Q})$. Table M-2 describes where the $(\overline{X/Q})_D$ value should be obtained from.

2.6.4.3 Determine the Pathway Tritium dose factor (R_{H-3}) for the organ τ of interest from the Table specified below.

AGE	INHALATION	MILK	
		COW	GOAT
Infant	G-4	G-5	G-6

2.6 (cont)

2.6.4 (cont)

2.6.4.4 Obtain the micro-Curies (Q) of Tritium from the radioactive gas waste management logs (for projected doses - the micro-Curies of nuclide(i) to be projected) for the release source(s) under consideration during the time interval. The dose can be calculated from a single release source, but the total dose for S.T.S. limits or quarterly reports shall be from all gaseous release sources.

2.6.4.5 Solve for D_{H-3}

$$D_{H-3} = 3.17 \times 10^{-8} \, R_{H-3} (\overline{X/Q})_D Q$$

D_{H-3} = mrem from Tritium in the specified pathway for ogran τ of the specified age group.

2.6.5 Determining the Total Organ Dose from Iodines, 8D-Particulates, and H-3 from Cumulative Gaseous Releases

NOTE: STS LCO dose limits for I&8DP shall consider dose from all release sources from St. Lucie Unit 1.

2.6.5.1 The following pathways shall be summed to arrive at the total dose to organ τ from a release source, or if applicable to STS, from all release sources:

PATHWAY	DOSE(mrem)	Step # ref.
Inhalation (I&8DP)		2.6.1.6
Ground Plane (I&8DP)	(T.Body only)	2.6.2.6
Grass- -Milk (I&8DP)		2.6.3.7
Inhalation (H-3)		2.6.4.5
Grass- -Milk(H-3)		2.6.4.5
$Dose_\tau$ =	Sum of above	

2.6 (cont)

2.6.5 (cont)

2.6.5.2 The dose to each of the INFANT's ORGANS shall be calculated:

BONE, LIVER, THYROID, KIDNEY, LUNG, TOTAL BODY & GI-LLI

The INFANT organ receiving the highest exposure relative to its STS Limit is the most critical organ for the radioiodine & 8D Particulates gaseous effluents.

2.7 Projecting Dose for Radioactive Gaseous Effluents

Discussion - Technical Specification 3.11.2.4 requires that the gaseous radwaste treatment system be used to reduce radioactive materials in waste prior to discharge when the projected dose due to gaseous effluents would exceed 0.4 mrad for gamma radiation and 0.8 mrad for beta radiation. The following calculation method is provided for determining the projected doses. This method is based on using the results of the calculations performed in Sections 2.4 and 2.5.

2.7.1 Obtain the latest results of the monthly calculations of the gamma air dose (Section 2.4) and the beta air dose if performed (Section 2.5). These doses can be obtained for the in-plant logs.

2.7.2 Divide these doses by the number of days the plant was operational during the month.

2.7.3 Multiply the quotient by the number of days the plant is projected to be operational during the next month. The product is the projected dose for the next month. The value should be adjusted as needed to account for any changes in failed-fuel or other identifiable operating conditions that could significantly alter the actual releases.

2.7.4 If the projected dose are greater than 0.4 mrads gamma air dose or (0.8 mrads beta air dose), the appropriate subsystems of the gaseous radwaste system shall be used to reduce the radioactivity levels prior to release.

3.0 40 CFR 190 Dose Evaluation

Discussion -

Dose or dose commitment to a real individual from all uranium fuel cycle sources be limited to ≤ 25 mrem to the total body or any organ (except thyroid, which is limited to ≤ 75 mrem) over a period of 12 consecutive months. The following approach should be used to demonstrate compliance with these dose limits. This approach is based on NUREG-0133, Section 3.8.

3.0.1 Evaluation Bases

Dose evaluations to demonstrate compliance with the above dose limits need only be performed if the quarterly doses calculated in Sections 1.4, 2.4 and 2.6 exceed twice the dose limits of Technical Specifications 3.11.1.2.a, 3.11.2.2a, and 3.11.2.3a, respectively; ie, quarterly doses exceeding 3 mrem to the total body (liquid releases), 10 mrem to any organ (liquid releases), 10 mrads gamma air dose, 20 mrads beta air dose, or 15 mrem to the thyroid or any organ from radioiodines and particulates (atmospheric releases). Otherwise, no evaluations are required and the remainder of this section can be omitted.

3.0.2 Doses From Liquid Releases

For the evaluation of doses to real individuals from liquid releases, the same calculation method as employed in Section 1.4 will be used. However, more realistic assumptions will be made concerning the dilution and ingestion of fish and shellfish by individuals who live and fish in the area. Also, the results of the Radiological Environmental Monitoring program will be included in determining more realistic dose to these real people by providing data on actual measured levels of plant related radionuclides in the environment.

3.0.3 Doses From Atmospheric Releases

For the evaluation of doses to real individuals from the atmospheric releases, the same calculation methods as employed in Section 2.4 and 2.6 will be used. In Section 2.4, the total body dose factor (K_i) should be substituted for the gamma air dose factor (M_i) to determine the total body dose. Otherwise the same calculation sequence applies. However, more realistic assumptions will be made concerning the actual location of real individuals, the meteorological conditions, and the consumption of food (eg, milk). Data obtained from the latest land use census (Technical Specification 3.12.2) should be used to determine locations for evaluating doses. Also, the results of the Radiological Environmental Monitoring program will be included in determining more realistic doses to these real people by providing data on actual measured levels of radioactivity and radiation at locations of interest.

4.0 SEMIANNUAL RADIOACTIVE EFFLUENT REPORT

Discussion - The information contained in a semiannual report shall not apply to any STS LCO. The reported values are based on real release conditions instead of historical conditions that the STS LCO dose calculations are based on. The STS LCO dose limits are therefore included in item 1, of the report, for information only. The MPC's in item 2, of the report, shall be those listed in Tables L-1 and G-1 of this manual. The average energy in item 3, of the report, is not applicable to the St. Lucie Plant. An unplanned release is defined as an abnormal release in Reg Guide 1.21 Rev. 1 which is an unplanned or uncontrolled release of radioactive material from the site boundary. The format, order of nuclides, and any values shown as an example in Tables 3.3 through 3.8, are samples only. Other formats are acceptable if they contain equivalent information. A table of contents should also accompany the report. The following format should be used:

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION

1. Regulatory Limits:

1.1 For Radioactive liquid waste effluents:

a) The once diluted concentration of radioactive material released from the site to unrestricted areas (see Figure 3.11-1 in STS-A) shall be limited to the concentrations specified in 10CFR20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases The once diluted concentration for total dissolved or entrained noble gases shall be limited to 2×10^{-4} μCi/mℓ.

b) The dose or dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas (see Figure 3.11-1 in STS-A) shall be limited during any calendar quarter to $\leq$ 1.5 mrem to the total body and to $\leq$ 5 mrem to any organ.

1.2 For Radioactive Gaseous Waste Effluents:

a) The instantaneous dose rate in unrestricted areas (see Figure 3.11-1 in the STS-A) due to radioactive materials released in gaseous effluents from the site shall be limited to the following values:

The dose rate limit for noble gases shall be < 500 mrem/yr to the total body and < 3000 mrem/yr to the skin, and

The dose rate limit for the INHALATION pathway from I-131, Tritium, and particulates with half-lives greater than 8 days shall be less than 1500 mrem/yr to any organ.

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION (cont)

1. Regulatory Limits: (cont)

1.2 For Radioactive Gaseous Waste Effluents: (cont)

b) The dose in unrestricted areas (see Figure 3.11-1 in the STS-A) due to noble gases released in gaseous effluents shall be limited to the following:

During any calendar quarter, to ≤ 5 mrad for gamma radiation and ≤ 10 mrad for beta radiation;

c) The dose to an individual from radioiodines, radioactive materials in particulate form, and radionuclides other than noble gases with half-lives greater than 8 days in gaseous effluents released to unrestricted areas (see Figure 3.11-1 in the STS-A) shall be limited to the following:

During any calendar quarter to ≤ 7.5 mrem to

2. Maximum Permissible Concentrations.

Air - as per attached Table G-1.

Water - as per attached Table L-1.

3. Average energy of fission and activation gases in gaseous effluents is not applicable to the St. Lucie Plant.

4. Measurements and Approximations of Total Radioactivity.

A summary of liquid effluent accounting methods is described in Table 3.1.

A summary of gaseous effluent accounting methods is described in Table 3.2.

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION (cont)

4. Measurements and Approximations of Total Radioactivity (cont)

Estimate of Errors

(a) Sampling Error

The error associated with volume measurement devices, flow measuring devices, etc. based on calibration data and design tolerances has been conservatively estimated collectively to be less than ± ________%.

(b) Analytical Error for Nuclides

Type	Average %	Maximum %
Liquid	±	±
Gaseous	±	±

Table 3.1
Radioactive Liquid Effluent Sampling and Analysis

LIQUID SOURCE	SAMPLING FREQUENCY	TYPE OF ANALYSIS	METHOD OF ANALYSIS
MONITOR TANK RELEASES[1]	EACH BATCH	PRINCIPAL GAMMA EMITTERS	p.h.a.
	MONTHLY COMPOSITE	Tritium	L.S.
		Gross Alpha	G.F.P.
	QUARTERLY COMPOSITE	Sr-89, Sr-90	C.S.& L.S.
STEAM GENERATOR BLOWDOWN RELEASES	WEEKLY	Principal Gamma Emitters and Dissolved Gases	p.h.a.
	MONTHLY COMPOSITE	Tritium	L.S.
		Gross Alpha	L.F.P.
	QUARTERLY COMPOSITE	Sr-89, Sr-90	C.S.&L.S.

TABLE NOTATION:

[1]Boric Acid Evaporator condensate is normally recovered to the Primary Water Storage Tank for recycling into the reactor coolant system and does not contribute to liquid waste effluent totals.

p.h.a. - gamma spectrum pulse height analysis using Lithium Germanium detectors. All peaks are identified and quantified.

L.S. - Liquid Scintillation counting

C.S. - Chemical Separation

G.F.P. - Gas Flow Proportional Counting

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION (cont)

4. Measurements and Approximations of Total Radioactivity (cont)

(b) Analytical Error for Nuclides (cont)

Table 3.2
Radioactive Gaseous Waste Sampling and Analysis

Gaseous Source	Sampling Frequency	Type of Analysis	Method of Analysis
Waste Gas Decay Tank Releases	Each Tank	Principal Gamma Emitters	(G, C, P) - p.h.a.
		H-3	L.S.
Containment Purge Releases	Each Purge	Principal Gamma Emitters	(G, C, P) - p.h.a.
		H-3	L.S.
Plant Vent	Weekly	Principal Gamma Emitters	(G, C, P) - p.h.a.
		H-3	L.S.
	Monthly Composite (Particulates)	Gross Alpha	P - G.F.P.
	Quarterly Composite (Particulates)	Sr-90, 89	C.S. & L.S.

G - Gaseous Grab Sample
C - Charcoal Filter Sample
P - Particulate Filter Sample
L.S. - Liquid Scintillation Counting
C.S. - Chemical Separation
p.h.a. - Gamma spectrum pulse height analysis using Lithium Germanium detectors. All peaks are identified and quantified.
G.F.P. - Gas Flow Proportional Counting

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION (cont)

5. Batch Releases

A. Liquid

1. Number of batch releases:
2. Total time period of batch releases: Minutes
3. Maximum time period for a batch release: Minutes
4. Average time period for a batch release: Minutes
5. Minimum time period for a batch release: Minutes
6. Average stream flow during periods of release of effluent into a flowing stream: GPM

All liquid releases are summarized in tables

B. Gaseous

1. Number of batch releases:
2. Total time period for batch releases: Minutes
3. Maximum time period for a batch release: Minutes
4. Average time period for batch releases: Minutes
5. Minimum time period for a batch release: Minutes

All gaseous waste releases are summarized in tables

6. Unplanned Releases

A. Liquid

1. Number of releases:
2. Total activity releases: Curies

B. Gaseous

1. Number of releases:
2. Total activity released: Curies

C. See attachments (if applicable) for:

1. A description of the event and equipment involved.
2. Cause(s) for the unplanned release.
3. Actions taken to prevent a recurrence.
4. Consequences of the unplanned release.

7. Description of dose assessment of radiation dose from radioactive effluents to the general public due to their activities inside the unrestricted area (see figure 3.11-1 in STS-A) during the reporting period:

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TABLE 3.3 : LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QUARTER#	QUARTER#
A. FISSION AND ACTIVATION PRODUCTS			
1. TOTAL RELEASE-NOT INCLUDING TRITIUM, GASES, ALPHA)	CI	2.379 E -1	9.819 E -1
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	1.983 E -8	7.439 E -8
B. TRITIUM			
1. TOTAL RELEASE	CI	2.029 E 1	4.509 E 1
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	1.691 E -6	3.416 E -6
C. DISSOLVED AND ENTRAINED GASES			
1. TOTAL RELEASE	CI	7.379 E -1	2.919 E -1
2. AVERAGE DILUTED CONCENTRATION DURING PERIOD	UCI/ML	6.150 E -8	2.212 E -8
D. GROSS ALPHA RADIOACTIVITY			
1. TOTAL RELEASE	CI	.000 E 0	.000 E 0
E. VOLUME OF WASTE RELEASED (PRIOR TO DILUTION)	LITERS	1.189 E 6	1.559 E 6
F. VOLUME OF DILUTION WATER USED DURING PERIOD	LITERS	1.199 E 10	1.319 E 10

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TABLE 3.4.: LIQUID EFFLUENTS

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNIT	QUARTER#	QUARTER#	QUARTER#	QUARTER#
I-131	CI	.000 E 0	.000 E 0	1.559 E -2	1.709 E -1
I-133	CI	.000 E 0	.000 E 0	8.080 E -4	7.420 E -3
I-135	CI	.000 E 0	.000 E 0	4.170 E -5	5.669 E -3
NA- 24	CI	.000 E 0	.000 E 0	1.639 E -4	3.900 E -5
CR- 51	CI	.000 E 0	.000 E 0	7.720 E -3	6.379 E -2
MN- 54	CI	.000 E 0	.000 E 0	9.479 E -3	1.620 E -2
CO- 57	CI	.000 E 0	.000 E 0	4.270 E -4	7.229 E -4
CO- 58	CI	.000 E 0	.000 E 0	7.539 E -2	2.789 E -1
FE- 59	CI	.000 E 0	.000 E 0	2.210 E -3	4.279 E -3
CO- 60	CI	.000 E 0	.000 E 0	6.199 E -2	1.269 E -1
ZN- 65	CI	.000 E 0	.000 E 0	4.200 E -4	1.339 E -3
NI- 65	CI	.000 E 0	.000 E 0	4.110 E -4	1.010 E -3
AG-110M	CI	.000 E 0	.000 E 0	9.990 E -4	5.970 E -4
SN-113	CI	.000 E 0	.000 E 0	9.830 E -4	1.780 E -3
SB-122	CI	.000 E 0	.000 E 0	3.000 E -4	4.439 E -3
SB-124	CI	.000 E 0	.000 E 0	5.429 E -4	3.319 E -2
W-187	CI	.000 E 0	.000 E 0	1.230 E -3	7.860 E -3
NP-239	CI	.000 E 0	.000 E 0	7.099 E -5	3.570 E -4
ZR- 95	CI	.000 E 0	.000 E 0	4.039 E -2	8.809 E -2
MO- 99	CI	.000 E 0	.000 E 0	2.680 E -5	1.099 E -2
RU-103	CI	.000 E 0	.000 E 0	.000 E 0	1.430 E -4
CS-134	CI	.000 E 0	.000 E 0	4.599 E -3	5.220 E -2
CS-136	CI	.000 E 0	.000 E 0	3.040 E -4	3.060 E -3
CS-137	CI	.000 E 0	.000 E 0	9.149 E -3	8.789 E -2
BA-140	CI	.000 E 0	.000 E 0	4.610 E -5	1.360 E -3
CE-141	CI	.000 E 0	.000 E 0	2.599 E -5	1.869 E -4
BR- 82	CI	.000 E 0	.000 E 0	.000 E 0	5.980 E -4
ZR- 97	CI	.000 E 0	.000 E 0	1.570 E -3	9.049 E -3
SB-125	CI	.000 E 0	.000 E 0	9.209 E -4	4.770 E -3
CE-144	CI	.000 E 0	.000 E 0	1.689 E -3	6.219 E -3
SR- 89	CI	.000 E 0	.000 E 0	.000 E 0	
SR- 90	CI	.000 E 0	.000 E 0	6.599 E -8	
UNIDENTIFIED	CI	.000 E 0	.000 E 0	.000 E 0	.000 E 0
TOTAL FOR PERIOD (ABOVE)	CI	.000 E 0	.000 E 0	2.375 E -1	9.822 E -1
AR- 41	CI	.000 E 0	.000 E 0	1.390 E -4	1.350 E -3
KR- 85	CI	.000 E 0	.000 E 0	6.689 E -4	1.719 E -3
XE-131M	CI	.000 E 0	.000 E 0	5.750 E -5	1.179 E -2
XE-133	CI	.000 E 0	.000 E 0	7.349 E -1	2.759 E -1
XE-133M	CI	.000 E 0	.000 E 0	2.450 E -3	6.679 E -4
XE-135	CI	.000 E 0	.000 E 0	6.860 E -5	4.689 E -4

FLORIDA POWER & LIGHT COMPANY

St. Lucie Unit #1

Table 3.5
Liquid Effluents - Dose Summation

Age Group: Adult Location: Any Adult

Exposure Interval: From ________ through ________

	Quarter #	Quarter #
Fish & Shellfish Pathway to ORGAN	DOSE (mrem)	DOSE (mrem)
BONE		
LIVER		
THYROID		
KIDNEY		
LUNG		
GI-LLI		
T. BODY		

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT#1

SEMIANNUAL REPORT JULY 1, 1978 THROUGH DECEMBER 31, 1978

TABLE 3.6 : GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QUARTER#	QUARTER#
A. FISSION AND ACTIVATION GASES			
1. TOTAL RELEASE	CI	7.077 E 3	9.759 E 3
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	8.976 E 2	1.238 E 3
B. IODINES			
1. TOTAL IODINE-131	CI	1.976 E -2	4.660 E -2
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	2.507 E -3	5.911 E -3
C. PARTICULATES			
1. PARTICULATES T-1/2 > 8 DAYS	CI	1.976 E -2	4.661 E -2
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	2.507 E -3	5.911 E -3
GROSS ALPHA RADIOACTIVITIY	CI	.000 E 0	.000 E 0
D. TRITIUM			
1. TOTAL RELEASE	CI	1.261 E 2	2.526 E 2
2. AVERAGE RELEASE RATE FOR PERIOD	UCI/SEC	1.600 E 1	3.203 E 1

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT #1

SEMIANNUAL REPORT JULY 1, 1978 THROUGH DECEMBER 31, 1978

TABLE 3.7: GASEOUS EFFLUENTS

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNIT	QUARTER#	QUARTER#	QUARTER#	QUARTER#
1. FISSION GASES					
AR- 41	CI	.000 E 0	.000 E 0	3.429 E 0	3.179 E 0
KR- 85	CI	.000 E 0	.000 E 0	1.939 E 1	2.899 E 1
KR- 85M	CI	.000 E 0	1.419 E 0	3.459 E 2	9.019 E 1
KR- 87	CI	.000 E 0	.000 E 0	7.479 E 1	3.899 E 1
KR- 88	CI	.000 E 0	2.739 E 0	4.139 E 2	1.369 E 2
XE-131M	CI	.000 E 0	.000 E 0	4.809 E 1	3.559 E 2
XE-133	CI	7.899 E 2	4.109 E 3	5.039 E 3	4.699 E 3
XE-133M	CI	3.569 E 0	4.399 E 1	2.849 E 1	3.709 E 1
XE-135	CI	3.669 E 1	1.089 E 2	1.049 E 2	4.939 E 1
XE-135M	CI	.000 E 0	.000 E 0	2.439 E 1	2.119 E 0
XE-138	CI	.000 E 0	.000 E 0	1.459 E 2	5.179 E 1
UNIDENTIFIED	CI	.000 E 0	.000 E 0	.000 E 0	.000 E 0
TOTAL FOR PERIOD (ABOVE)	CI	8.302 E 2	4.267 E 3	6.249 E 3	5.494 E 3
2. IODINES					
I-131	CI	1.229 E -2	2.049 E -2	7.460 E -3	2.609 E -2
I-133	CI	4.379 E -1	2.279 E -1	4.570 E -6	8.430 E -5
I-135	CI	.000 E 0	.000 E 0	.000 E 0	1.120 E -5
TOTAL FOR PERIOD (ABOVE)	CI	4.502 E -1	2.484 E -1	7.464 E -3	2.619 E -2
3. PARTICULATES					
CO- 58	CI	.000 E 0	3.489 E -6	.000 E 0	.000 E 0
SR- 89	CI	4.800 E -6	.000 E 0	.000 E 0	.000 E 0
SR- 90	CI	8.220 E -6	.000 E 0	.000 E 0	.000 E 0

FLORIDA POWER & LIGHT COMPANY

St. Lucie Unit #1

Table 3.8

Gaseous Effluents - Dose Summation - Quarter# ____________

Age Group: Infant Exposure Interval: From ____________ through ____________

Pathway	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem)	GI-LII (mrem)	T. BODY (mrem)
Ground Plane							
Grass- -Milk							
Inhalation							
Total							
Sector:	Range:	miles		Cow/Goat	Sector: ______	Range: _____	miles

Noble Gases	Quarter (Above time interval) mrad	Calendar Year (mrad)
Gamma Air Dose		
Beta Air Dose		
Sector: Range: 0.97 miles		

1 - The dose values below were calculated using real meteorological data during the specified time interval with met data reduced as per Reg. Guide 1.111, March 1976.

APPENDIX A

MPC, DOSE FACTOR, &

HISTORICAL METEOROLOGICAL

TABLES

TABLE L-1

Maximum Permissible Concentrations in Water in Unrestricted Areas

Nuclide[1]	MPC(µCi/ml)	Nuclide[1]	MPC(µCi/ml)	Nuclide[1]	MPC(µCi/ml)
H-3	3 E-3	Y-90	2 E-5	Te-129	8 E-4
Na-24	3 E-5	Y-91m	3 E-3	Te-131m	4 E-5
P-32	2 E-5	Y-91	3 E-5	Te-131	None
Cr-51	2 E-3	Y-92	6 E-5	Te-132	2 E-5
Mn-54	1 E-4	Y-93	3 E-5	I-130	3 E-6
Mn-56	1 E-4	Zr-95	6 E-5	I-131	3 E-7
Fe-55	8 E-4	Zr-97	2 E-5	I-132	8 E-6
Fe-59	5 E-5	Nb-95	1 E-4	I-133	1 E-6
Co-57	4 E-4	Nb-97	9 E-4	I-134	2 E-5
Co-58	9 E-5	Mo-99	4 E-5	I-135	4 E-6
Co-60	3 E-5	TC-99m	3 E-3	Cs-134	9 E-6
Ni-65	1 E-4	Tc-101	None	Cs-136	6 E-5
Cu-64	2 E-4	Ru-103	8 E-5	Cs-137	2 E-5
Zn-65	1 E-4	Ru-105	1 E-4	Cs-138	None
Zn-69	2 E-3	Ru-106	1 E-5	Ba-139	None
Br-82	4 E-5	Ag-110m	3 E-5	Ba-140	2 E-5
Br-83	3 E-6	Sn-113	8 E-5	Ba-141	None
Br-84	None[2]	In-113m	1 E-3	Ba-142	None
Br-85	None	Sb-122	3 E-5	La-140	2 E-5
Rb-86	2 E-5	Sb-124	2 E-5	La-142	None
Rb-88	None	Sb-125	1 E-4	Ce-141	9 E-5
Rb-89	None	Te-125M	1 E-4	Ce-143	4 E-5
Sr-89	3 E-6	Te-127m	5 E-5	Ce-144	1 E-5
Sr-90	3 E-7	Te-127	2 E-4	Pr-144	None
Sr-91	5 E-5	Te-129m	2 E-5	W-187	6 E-5
Sr-92	6 E-5			Np-239	1 E-4

(1) If a nuclide is not listed, refer to 10 CFR 20, Appendix B, and use the most conservative insoluble/soluble MPC where they are given in Table II, Column 2.

(2) None-(As per 10 CFR 20, Appendix B) 'No MPC limit for any single radionuclide not listed above with decay mode other than apha emission or spontaneous fission and with radioactive half-life less than 2 hours'.

TABLE L-2

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES

PATHWAY - SALT WATER FISH AND SHELLFISH   AGE GROUP - ADULT

NUCLIDE	ORGAN DOSE FACTOR (MREM/HR PER UCI/ML)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
H----3	0.	3.60E-01	3.60E-01	3.60E-01	3.60E-01	3.60E-01	0.	3.60E-01
NA--24	6.08E-01	6.08E-01	6.08E-01	6.08E-01	6.08E-01	6.08E-01	0.	6.08E-01
P---32	1.67E+07	1.05E+06	0.	0.	0.	1.83E+06	0.	6.47E+05
CR--51	0.	0.	3.34E+00	1.23E+00	7.42E+00	1.41E+03	0.	5.59E+00
MN--54	0.	7.07E+03	0.	2.10E+03	0.	2.17E+04	0.	1.35E+03
MN--56	0.	1.78E+02	0.	2.26E+02	0.	5.65E+03	0.	3.17E+01
FE--55	1.15E+05	5.19E+05	0.	0.	6.01E+05	2.03E+05	0.	1.36E+05
FE--59	8.08E+04	1.92E+05	0.	0.	5.32E+04	6.33E+05	0.	7.29E+04
CO--57	0.	1.42E+02	0.	0.	0.	3.60E+03	0.	2.36E+02
CO--58	0.	6.35E+02	0.	0.	0.	1.22E+04	0.	1.35E+03
CO--60	0.	1.74E+03	0.	0.	0.	3.26E+04	0.	3.83E+03
NI--65	2.02E+02	2.63E+01	0.	0.	0.	6.65E+02	0.	1.20E+01
CU--64	0.	2.15E+02	0.	5.41E+02	0.	1.83E+04	0.	1.01E+02
ZN--65	1.62E+05	5.13E+05	0.	3.43E+05	0.	3.23E+05	0.	2.32E+05
ZN--69	3.43E+02	6.60E+02	0.	4.27E+02	0.	9.87E+01	0.	4.57E+01
BR--82	0.	0.	0.	0.	0.	4.68E+00	0.	4.08E+00
BR--83	0.	0.	0.	0.	0.	1.05E-01	0.	7.26E-02
BR--84	0.	0.	0.	0.	0.	7.38E-07	0.	9.42E-02
BR--85	0.	0.	0.	0.	0.	0.	0.	3.86E-03
RB--86	0.	6.25E+02	0.	0.	0.	1.23E+02	0.	2.91E+02
RB--88	0.	1.79E+00	0.	0.	0.	0.	0.	9.50E-01
RB--89	0.	1.19E+00	0.	0.	0.	0.	0.	8.38E-01
SR--89	5.01E+03	0.	0.	0.	0.	8.01E+02	0.	1.44E+02
SR--90	1.23E+05	0.	0.	0.	0.	1.65E+03	0.	3.02E+04
SR--91	9.43E+01	0.	0.	0.	0.	4.75E+02	0.	4.15E+00
SR--92	3.50E+01	0.	0.	0.	0.	6.91E+02	0.	1.51E+00
Y---90	6.07E+00	0.	0.	0.	0.	6.43E+04	0.	1.63E-01
Y--91M	5.74E-02	0.	0.	0.	0.	1.68E-01	0.	2.23E-03
Y---91	8.89E+01	0.	0.	0.	0.	4.89E+04	0.	2.38E+00
Y---92	5.34E-01	0.	0.	0.	0.	9.33E+03	0.	1.56E-02
Y---93	1.69E+00	0.	0.	0.	0.	5.36E+04	0.	4.67E-02
ZR--95	1.60E+01	5.13E+00	0.	8.09E+00	0.	1.59E+04	0.	3.47E+00
ZR--97	8.82E-01	1.78E-01	0.	2.69E-01	0.	5.51E+04	0.	8.19E-02
NB--95	4.43E+02	2.49E+02	0.	2.47E+02	0.	1.51E+06	0.	9.79E+01
NB--97	3.76E+00	9.50E-01	0.	1.11E+00	0.	3.51E+03	0.	3.47E-01
MO--99	0.	1.26E+02	0.	2.90E+02	0.	2.97E+02	0.	2.43E+01
TC-99M	1.30E-02	3.67E-02	0.	5.57E-01	1.80E-02	2.17E+01	0.	4.67E-01

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN DISCHARGE FLOW OF 1 CC/SEC WITH NO ADDITIONAL DILUTION

TABLE L-2 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES

PATHWAY - SALT WATER FISH AND SHELLFISH　　　　AGE GROUP - ADULT

NUCLIDE	ORGAN DOSE FACTOR (MREM/HR PER UCI/ML)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
TC-101	1.33E-02	1.93E-02	0.	3.47E-01	9.82E-03	0.	0.	1.89E-01
RU-103	1.07E+02	0.	0.	4.09E+02	0.	1.25E+04	0.	4.61E+01
RU-105	9.90E+00	0.	0.	1.15E+02	0.	5.44E+03	0.	3.51E+00
RU-106	1.59E+03	0.	0.	3.08E+03	0.	1.03E+05	0.	2.01E+02
AG110M	1.57E+03	1.45E+03	0.	2.85E+03	0.	5.92E+05	0.	8.62E+02
SB-122	0.	0.	0.	0.	0.	0.	0.	0.
SB-124	2.78E+02	5.23E+00	6.71E-01	0.	2.15E+02	7.85E+03	0.	1.10E+02
SB-125	2.20E+02	2.37E+00	1.96E-01	0.	2.30E+04	1.95E+03	0.	4.42E+01
TE125M	2.17E+02	7.89E+01	6.54E+01	8.63E+02	0.	8.67E+02	0.	2.91E+01
TE127M	5.50E+02	1.92E+02	1.40E+02	2.23E+03	0.	1.84E+03	0.	6.70E+01
TE-127	8.92E+00	3.20E+00	6.61E+00	3.63E+01	0.	7.04E+02	0.	1.93E+00
TE129M	9.32E+02	3.49E+02	3.20E+02	3.89E+03	0.	4.69E+03	0.	1.48E+02
TE-129	2.55E+00	9.65E-01	1.95E+00	1.07E+01	0.	1.92E+00	0.	6.21E-01
TE131M	1.41E+02	6.87E+01	1.09E+02	6.95E+02	0.	6.81E+03	0.	5.72E+01
TE-131	1.60E+00	6.68E-01	1.31E+00	7.00E+00	0.	2.39E-01	0.	5.04E-01
TE-132	2.35E+03	1.33E+02	1.46E+02	1.28E+03	0.	6.25E+03	0.	1.24E+02
I--130	3.93E+01	1.18E+02	1.59E+04	1.83E+02	0.	1.01E+02	0.	4.63E+01
I--131	2.18E+02	3.13E+02	1.02E+05	5.36E+02	0.	8.24E+01	0.	1.79E+02
I--132	1.07E+01	2.85E+01	3.76E+03	4.55E+01	0.	5.36E+00	0.	1.01E+01
I--133	7.51E+01	1.30E+02	2.51E+04	2.27E+02	0.	1.15E+02	0.	3.98E+01
I--134	5.57E+00	1.51E+01	1.96E+03	2.41E+01	0.	1.32E-02	0.	5.41E+00
I--135	2.33E+01	6.14E+01	8.03E+03	9.77E+01	0.	6.88E+01	0.	2.25E+01
CS-134	6.85E+03	1.63E+04	0.	5.29E+03	1.75E+03	2.85E+02	0.	1.33E+04
CS-136	7.17E+02	2.83E+03	0.	1.58E+03	2.16E+02	3.22E+02	0.	2.04E+03
CS-137	8.79E+03	1.20E+04	0.	4.09E+03	1.36E+03	2.31E+02	0.	7.88E+03
CS-138	6.08E+00	1.20E+01	0.	8.84E+00	8.73E-01	5.12E-05	0.	5.96E+00
BA-139	7.87E+00	5.61E-03	0.	5.24E-03	3.18E-03	1.39E+01	0.	2.30E-01
BA-140	1.65E+03	2.07E+00	0.	7.04E-01	1.18E+00	3.39E+03	0.	1.09E+02
BA-141	0.	2.89E-03	0.	2.63E-03	1.64E-03	1.80E-09	0.	1.29E-01
BA-142	1.73E+00	1.78E-03	0.	1.50E-03	1.01E-03	0.	0.	1.09E-01
LA-140	1.58E+00	7.95E-01	0.	0.	0.	5.83E+04	0.	2.11E-01
LA-142	8.07E-02	3.67E-02	0.	0.	0.	2.68E+02	0.	9.15E-03
CE-141	3.43E+00	2.32E+00	0.	1.08E+00	0.	8.87E+03	0.	2.63E-01
CE-143	6.05E-01	4.47E+02	0.	1.97E-01	0.	1.67E+04	0.	4.95E-02
CE-144	1.79E+02	7.48E+01	0.	4.43E+01	0.	6.05E+04	0.	9.60E+00
PR-144	1.91E-02	7.38E-03	0.	4.45E-03	0.	2.73E-09	0.	9.65E-04
W--187	9.17E+00	7.68E+00	0.	0.	0.	2.51E+03	0.	2.69E+00
NP-239	3.56E-02	3.50E-03	0.	1.08E-02	0.	7.12E+02	0.	1.92E-03

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN DISCHARGE FLOW OF 1 CC/SEC WITH NO ADDITIONAL DILUTION

TABLE G-1

Maximum Permissible Concentrations in Air in Unrestricted Areas

Nuclide[1]	MPC µCi/cc	Nuclide[1]	MPC µCi/cc
Ar-41	4 E-8	Y-91	1 E-9
Kr-83m	3 E-8	Zr-95	1 E-9
Kr-85m	1 E-7	Nb-95	3 E-9
Kr-85	3 E-7	Ru-103	3 E-9
Kr-87	2 E-8	Ru-106	2 E-10
Kr-88	2 E-8	Ag-110m	3 E-10
Kr-89	3 E-8	Sn-113	2 E-9
Kr-90	3 E-8	In-113m	2 E-7
Xe-131m	4 E-7	Sn-123	1 E-10
Xe-133m	3 E-7	Sn-126	1 E-10
Xe-133	3 E-7	Sb-124	7 E-10
Xe-135m	3 E-8	Sb-125	9 E-10
Xe-135	1 E-7	Te-125m	4 E-9
Xe-137	3 E-8	Te-127m	1 E-9
Xe-138	3 E-8	Te-129m	1 E-9
H-3	2 E-7	I-130	1 E-10
P-32	2 E-9	I-131	1 E-10
Cr-51	8 E-8	I-132	3 E-9
Mn-54	1 E-9	I-133	4 E-10
Fe-59	2 E-9	I-134	6 E-9
Co-57	6 E-9	I-135	1 E-9
Co-58	2 E-9	Cs-134	4 E-10
Co-60	3 E-10	Cs-136	6 E-9
Zn-65	2 E-9	Cs-137	5 E-10
Rb-86	2 E-9	Ba-140	1 E-9
Sr-89	3 E-10	La-140	4 E-9
Sr-90	3 E-11	Ce-141	5 E-9
Rb-88	3 E-8	Ce-144	2 E-10

(1) If a nuclide is not listed, refer to 10 CFR 20, Appendix B, and use the most conservative insoluble/soluble MPC where they are given in Table II, Column 1.

TABLE G-2

DOSE FACTORS FOR NOBLE GASES*

Radionuclide	Total Body Dose Factor K_i (mrem/yr per µCi/m^3)	Skin Dose Factor L_i (mrem/yr per µCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per µCi/m^3)	Beta Air Dose Factor N_i (mrad/yr per µCi/m^3)
Kr-83m	7.56E-02**	---	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.
**7.56E-02 = 7.56×10^{-2}.

TABLE G-3

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS P(I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION - Instantaneous AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
H----3								0.
P---32								0.
CR--51								6.68E+06
MN--54								1.10E+09
FE--59								3.92E+08
CO--57								1.64E+08
CO--58								5.27E+08
CO--60								4.40E+09
ZN--65								6.87E+08
RB--86								1.29E+07
SR--89								3.07E+04
SR--90								5.94E+05
Y---91								1.53E+06
ZR--95								6.94E+08
NB--95								1.95E+08
RU-103								1.57E+08
RU-106								2.99E+08
AG110M								3.18E+09

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-3 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS P(I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION - Instantaneous | AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
SN-123								0.
SN-126								4.80E+09
SB-124								8.42E+08
SB-125								7.56E+08
TE125M								2.19E+06
TE127M								1.15E+06
TE129M								5.49E+07
I--130								7.90E+06
I--131								2.46E+07
I--132								1.78E+06
I--133								3.54E+06
I--134								6.43E+05
I--135								3.66E+06
CS-134								2.82E+09
CS-136								2.13E+08
CS-137								1.15E+09
BA-140								2.39E+08
CE-141								1.95E+07
CE-144								9.52E+07

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-4

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION - CUMULATIVE

AGE GROUP - CHILD - TEEN - ADULT & INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
H----3								0.
P---32								0.
CR--51								4.68E+06
MN--54								1.38E+09
FE--59								2.75E+08
CO--57								1.89E+08
CO--58								3.80E+08
CO--60								2.15E+10
ZN--65								7.43E+08
RB--86								9.01E+06
SR--89								2.17E+04
SR--90								5.35E+06
Y---91								1.08E+06
ZR--95								5.01E+08
NB--95								1.36E+08
RU-103								1.10E+08
RU-106								4.19E+08
AG110M								3.53E+09

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-4 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION - CUMULATIVE

AGE GROUP - CHILD - TEEN - ADULT & INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
SN-123								0.
SN-126								5.16E+10
SB-124								5.98E+08
SB-125								2.30E+09
TE 125M								1.55E+06
TE 127M								8.79E+05
TE 129M								3.85E+07
I--130								5.53E+06
I--131								1.72E+07
I--132								1.25E+06
I--133								2.48E+06
I--134								4.50E+05
I--135								2.56E+06
CS-134								6.99E+09
CS-136								1.49E+08
CS-137								1.03E+10
BA-140								1.68E+08
CE-141								1.37E+07
CE-144								1.13E+08

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-5

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - INHALATION | AGE GROUP - INFANT

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
	ORGAN DOSE FACTORS (MREM/YR PER UCI/CU.METER)							
H---3	0.	4.30E+02	4.30E+02	1.88E+02	4.30E+02	4.30E+02	0.	4.30E+02
P---32	2.31E+05	1.35E+04	0.	0.	0.	1.51E+04	0.	8.78E+03
CR--51	0.	0.	1.04E+01	3.99E+00	2.52E+03	5.81E+02	0.	1.75E+01
MN--54	0.	6.93E+03	0.	1.72E+03	2.45E+05	1.35E+04	0.	1.10E+03
FE--59	2.06E+03	4.86E+06	0.	0.	1.78E+05	3.29E+04	0.	1.85E+03
CO--57	0.	1.21E+02	0.	0.	6.47E+04	5.50E+03	0.	1.18E+02
CO--58	0.	1.18E+02	0.	0.	8.79E+05	1.21E+04	0.	1.60E+02
CO--60	0.	8.40E+02	0.	0.	5.57E+06	3.28E+04	0.	1.17E+03
ZN--65	5.67E+03	1.81E+04	0.	1.21E+04	1.53E+05	9.35E+03	0.	8.15E+03
RB--86	0.	2.37E+04	0.	0.	0.	2.91E+03	0.	1.03E+04
SR--89	4.31E+04	0.	0.	0.	2.31E+06	6.83E+04	0.	1.24E+03
SR--90	1.32E+07	0.	0.	0.	1.53E+07	1.39E+05	0.	8.06E+05
Y---91	5.98E+04	0.	0.	0.	2.63E+06	7.17E+04	0.	1.60E+03
ZR--95	1.03E+04	2.73E+03	0.	9.48E+03	1.81E+06	1.41E+04	0.	1.95E+03
NB--95	1.28E+03	5.75E+02	0.	1.35E+03	4.77E+05	1.21E+04	0.	3.37E+02
RU-103	1.69E+02	0.	0.	1.02E+03	5.66E+05	1.58E+04	0.	5.65E+01
RU-106	9.31E+03	0.	0.	2.34E+04	1.59E+07	1.76E+05	0.	1.14E+03
AG110M	1.59E+03	1.75E+03	0.	3.44E+03	8.12E+05	5.29E+04	0.	1.04E+03

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-5 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - INHALATION AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (MREM/YR PER UCI/CU.METER)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
SN-123	3.11E+04	6.45E+02	6.45E+02	0.	3.61E+06	5.99E+04	0.	1.02E+03
SN-126	2.21E+05	5.85E+03	1.72E+03	0.	1.64E+06	2.23E+04	0.	8.40E+03
SB-124	5.46E+03	1.03E+02	1.32E+01	0.	4.34E+05	7.11E+04	0.	2.17E+03
SB-125	1.16E+04	1.25E+02	1.03E+01	0.	3.85E+05	1.76E+04	0.	2.32E+03
TE125M	4.54E+02	1.95E+02	1.53E+02	2.17E+03	4.96E+05	1.36E+04	0.	6.16E+01
TE127M	2.21E+03	9.83E+02	5.75E+02	8.01E+03	1.68E+05	2.62E+04	0.	2.74E+02
TE129M	1.32E+03	5.80E+02	5.08E+02	6.40E+03	1.83E+06	7.32E+04	0.	2.06E+02
I--130	6.02E+02	2.35E+03	3.05E+05	3.65E+03	0.	1.35E+03	0.	9.25E+02
I--131	3.63E+04	4.27E+04	1.41E+07	1.07E+04	0.	1.07E+03	0.	2.51E+04
I--132	2.03E+02	5.70E+02	7.67E+04	9.09E+02	0.	7.11E+01	0.	2.03E+02
I--133	1.34E+04	1.93E+04	4.66E+06	4.55E+03	0.	2.28E+03	0.	5.87E+03
I--134	1.13E+02	3.62E+02	4.02E+04	4.32E+02	0.	1.76E-01	0.	1.08E+02
I--135	4.70E+02	1.22E+03	1.64E+05	1.95E+03	0.	9.18E+02	0.	4.51E+02
CS-134	4.80E+05	8.25E+05	0.	5.04E+04	1.01E+05	1.37E+03	0.	7.32E+04
CS-136	6.85E+03	2.56E+04	0.	1.50E+04	2.10E+03	2.04E+03	0.	1.95E+04
CS-137	6.86E+05	7.31E+05	0.	3.59E+04	9.45E+04	1.32E+03	0.	4.41E+04
BA-140	5.70E+03	4.27E+00	0.	2.93E+00	1.64E+06	3.88E+03	0.	2.95E+02
CE-141	2.72E+03	1.55E+03	0.	1.10E+03	5.24E+05	2.06E+04	0.	1.81E+02
CE-144	4.93E+05	1.82E+05	0.	1.48E+05	1.27E+07	1.61E+05	0.	2.49E+04

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

TABLE G-6

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
H----3	0.	2.37E+03	2.37E+03	1.04E+03	2.37E+03	2.37E+03	0.	2.37E+03
P---32	1.32E+10	1.14E+09	0.	0.	0.	2.05E+09	0.	7.05E+08
CR--51	0.	0.	1.82E+04	6.72E+03	4.04E+04	7.66E+06	0.	3.05E+04
MN--54	0.	8.96E+06	0.	2.67E+06	0.	2.74E+07	0.	1.71E+06
FE--59	3.17E+07	7.52E+07	0.	0.	2.09E+07	2.48E+08	0.	2.86E+07
CO--57	0.	1.36E+06	0.	0.	0.	3.46E+07	0.	2.27E+06
CO--58	0.	2.55E+07	0.	0.	0.	6.60E+07	0.	6.24E+07
CO--60	0.	8.73E+07	0.	0.	0.	2.16E+08	0.	2.09E+08
ZN--65	1.46E+09	4.65E+09	0.	3.11E+09	0.	2.93E+09	0.	2.10E+09
RB--86	0.	2.77E+09	0.	0.	0.	5.45E+08	0.	1.29E+09
SR--89	1.47E+10	0.	0.	0.	0.	2.75E+08	0.	4.22E+08
SR--90	1.65E+11	0.	0.	0.	0.	1.61E+09	0.	4.21E+10
Y---91	8.12E+04	0.	0.	0.	0.	5.37E+06	0.	2.16E+03
ZR--95	2.12E+05	9.41E+04	0.	1.86E+04	0.	7.47E+07	0.	5.56E+04
NB--95	5.[illegible]3E+05	2.47E+05	0.	4.84E+04	0.	1.93E+08	0.	1.45E+05
RU-103	8.30E+03	0.	0.	4.16E+03	0.	1.04E+05	0.	2.86E+03
RU-106	2.01E+05	0.	0.	4.20E+04	0.	1.56E+06	0.	2.46E+04
AG110M	6.21E+07	5.75E+07	0.	1.13E+08	0.	2.35E+10	0.	3.42E+07

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

NOTE - THE UNITS FOR C---14 AND H----3 ARE (MREM/YR PER UCI/CU.METER)

TABLE G-6 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
SN-123	0.	0.	0.	0.	0.	0.	0.	0.
SN-126	1.75E+09	3.48E+07	1.01E+07	0.	4.97E+06	1.16E+09	0.	5.25E+07
SB-124	2.75E+07	5.19E+05	6.64E+04	0.	2.13E+07	7.78E+08	0.	1.09E+07
SB-125	3.59E+07	3.27E+06	2.93E+06	3.96E+06	2.83E+09	2.43E+08	0.	6.62E+06
TE125M	1.57E+08	5.30E+07	5.13E+07	7.05E+07	0.	7.57E+07	0.	2.10E+07
TE127M	5.54E+07	1.93E+07	1.79E+07	2.00E+08	0.	3.24E+08	0.	7.33E+06
TE129M	5.87E+08	2.02E+08	2.21E+08	2.70E+08	0.	3.54E+08	0.	8.95E+07
I--130	4.54E+05	1.35E+06	1.71E+08	2.09E+06	0.	1.15E+06	0.	5.29E+05
I--131	2.59E+09	3.09E+09	9.94E+11	7.74E+08	0.	1.16E+08	0.	1.81E+09
I--132	1.78E-01	4.76E-01	6.26E+01	7.58E-01	0.	8.93E-02	0.	1.69E-01
I--133	3.75E+07	5.48E+07	1.30E+10	1.29E+07	0.	9.74E+06	0.	1.66E+07
I--134	0.	0.	1.06E-39	0.	0.	0.	0.	0.
I--135	1.49E+04	3.94E+04	5.15E+06	6.26E+04	8.07E-02	4.41E+04	0.	1.44E+04
CS-134	4.43E+10	7.97E+10	0.	4.65E+09	9.12E+09	1.90E+08	0.	6.75E+09
CS-136	2.76E+08	1.10E+09	0.	6.11E+08	8.37E+07	1.25E+08	0.	7.90E+08
CS-137	6.44E+10	7.21E+10	0.	3.66E+09	8.69E+09	1.86E+08	0.	4.14E+09
BA-140	2.45E+08	2.47E+05	0.	1.22E+04	1.51E+05	8.13E+06	0.	1.27E+07
CE-141	2.65E+05	1.62E+05	0.	9.72E+03	0.	7.87E+07	0.	1.90E+04
CE-144	2.10E+07	8.29E+06	0.	5.67E+05	0.	8.66E+08	0.	1.13E+06

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

NOTE - THE UNITS FOR C---14 AND H----3 ARE (MREM/YR PER UCI/CU.METER)

TABLE G-7

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
H----3	0.	4.84E+03	4.84E+03	2.11E+03	4.84E+03	4.84E+03	0.	4.84E+03
P---32	2.19E+10	1.37E+09	0.	0.	0.	2.46E+09	0.	8.46E+08
CR--51	0.	0.	2.19E+03	8.07E+02	4.85E+03	9.19E+05	0.	3.66E+03
MN--54	0.	1.08E+06	0.	3.20E+05	0.	3.29E+06	0.	2.05E+05
FE--59	4.12E+05	9.78E+05	0.	0.	2.72E+05	3.23E+06	0.	3.72E+05
CO--57	0.	1.64E+05	0.	0.	0.	4.15E+06	0.	2.72E+05
CO--58	0.	3.06E+06	0.	0.	0.	7.92E+06	0.	7.49E+06
CO--60	0.	1.55E+07	0.	0.	0.	2.59E+07	0.	2.51E+07
ZN--65	1.76E+08	5.57E+08	0.	3.73E+08	0.	3.51E+08	0.	2.52E+08
RB--86	0.	3.32E+08	0.	0.	0.	6.54E+07	0.	1.55E+08
SR--89	3.09E+10	0.	0.	0.	0.	5.77E+08	0.	8.87E+08
SR--90	3.46E+11	0.	0.	0.	0.	3.35E+09	0.	6.83E+10
Y---91	9.74E+03	0.	0.	0.	0.	6.45E+05	0.	2.60E+02
ZR--95	2.54E+04	1.13E+04	0.	2.23E+03	0.	8.95E+06	0.	6.67E+03
NB--95	6.59E+04	2.97E+04	0.	5.81E+03	0.	2.37E+07	0.	1.75E+04
RU-103	9.96E+02	0.	0.	4.99E+02	0.	1.24E+04	0.	3.43E+02
RU-106	2.41E+04	0.	0.	5.04E+03	0.	1.67E+05	0.	2.96E+03
AG110M	7.49E+06	6.90E+06	0.	1.36E+07	0.	2.81E+09	0.	4.10E+06

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

NOTE - THE UNITS FOR C---14 AND H----3 ARE (MREM/YR PER UCI/CU.METER)

TABLE G-7 (con't)

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT

NUCLIDE	ORGAN DOSE FACTORS (SQ.METER-MREM/YR PER UCI/SEC)							
	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	SKIN	TOTAL BODY
SN-123	0.	0.	0.	0.	0.	0.	0.	0.
SN-125	2.10E+08	4.17E+06	1.22E+06	0.	5.97E+05	1.40E+08	0.	6.30E+06
SB-124	3.30E+06	6.22E+04	7.97E+03	0.	2.56E+06	9.33E+07	0.	1.30E+06
SB-125	4.31E+06	3.92E+05	3.52E+05	4.76E+05	3.40E+03	2.92E+07	0.	7.94E+05
TE125M	1.39E+07	6.36E+06	6.21E+06	8.46E+06	0.	9.09E+06	0.	2.52E+06
TE127M	6.64E+06	2.31E+06	2.15E+06	2.40E+07	0.	3.83E+07	0.	8.85E+05
TE129M	7.35E+07	2.42E+07	2.66E+07	3.23E+07	0.	4.25E+07	0.	1.07E+07
I--130	5.45E+05	1.61E+06	2.05E+08	2.51E+06	0.	1.38E+06	0.	6.35E+05
I--131	3.11E+09	3.70E+09	1.19E+12	9.28E+08	0.	1.39E+08	0.	2.17E+09
I--132	2.13E-01	5.71E-01	7.51E+01	9.10E-01	0.	1.07E-01	0.	2.03E-01
I--133	4.50E+07	6.57E+07	1.55E+10	1.55E+07	0.	1.17E+07	0.	1.99E+07
I--134	0.	0.	1.27E-09	0.	0.	0.	0.	0.
I--135	1.79E+04	4.72E+04	6.18E+06	7.51E+04	2.42E-01	5.29E+04	0.	1.73E+04
CS-134	1.33E+11	2.39E+11	0.	1.39E+10	2.74E+10	5.69E+08	0.	2.02E+10
CS-136	8.34E+08	3.29E+09	0.	1.83E+09	2.51E+08	3.74E+08	0.	2.37E+09
CS-137	1.93E+11	2.16E+11	0.	1.10E+10	2.61E+10	5.59E+08	0.	1.24E+10
BA-140	2.95E+07	2.96E+04	0.	1.47E+03	1.81E+04	9.76E+05	0.	1.52E+06
CE-141	3.17E+04	1.95E+04	0.	1.17E+03	0.	9.44E+06	0.	2.28E+03
CE-144	2.52E+06	9.95E+05	0.	6.80E+04	0.	1.04E+08	0.	1.36E+05

BASED ON 1 UCI/SEC RELEASE RATE OF EACH ISOTOPE IN AND A VALUE OF 1. FOR X/Q, DEPLETED X/Q AND RELATIVE DEPOSITION

NOTE - THE UNITS FOR C---14 AND H----3 ARE (MREM/YR PER UCI/CU.METER)

TABLE M-1

Selecting the Appropriate Long Term $(\overline{X/Q})$ for Dose Calculations Involving Noble Gases for:

(1) Total body dose from instantaneous releases

(2) Skin dose from instantaneous releases

(3) Gamma air dose (cumulative)

(4) Beta air dose (cumulative)

Type of Dose Calculation	Limiting Range (miles)	Limiting Sector	$(\overline{X/Q})$ Value sec/m^3
Instantaneous-LCO	0.97	N	1.6×10^{-6}
1/31 days-LCO	0.97	1. Normally $(\overline{X/Q}) = 1.6 \times 10^{-6}$ sec/m^3	
Quarterly-LCO yearly	0.97		
12 consecutive months – LCO	0.97	2. A $(\overline{X/Q})$, using a wind sector frequency calculation to determine the avg of the 16 sectors, may be used in lieu of 1 above.	
Annual Report	0.97	(NA)	Note-1

Note-1 – The $(\overline{X/Q})$ has to be calculated based on real meteorological data that occurred during the period of interest. The sector of interest is NA because the limiting $\overline{X/Q}$ will be determined from the actual meterological data.

0.97 miles – Corresponds to the minimum site boundary distance in the north direction and 0.97 miles was chosen for all other sectors for ease of calculations when the averaging is done for quarterly reports.

TABLE M-2

Selecting the Appropriate Long Term $(\overline{X/Q})_D$ or $(\overline{D/Q})$ for Dose Calculations Involving Radioiodines & 8 D Particulates for:

(1) Inhalation, (2) Tritium (All gas pathways), (3) Ground Plane

Type of Dose Calculation	Limiting Range Miles	Limiting Sector (OL)	$(\overline{X/Q})_D$ sec/m^3	$(\overline{D/Q})$ 1/m^2
Instantaneous LCO	0.97	NW	1.3×10^{-6}	
		WNW		8.2×10^{-9}
Quarterly for Semiannual Reports	0.97	A	A	
	0.97	A		A
1/31 days LCO, Qtr - yearly LCO, 12 consecutive month LCO.	0.97	NW	1.3×10^{-6}	
	0.97	WNW		8.2×10^{-9}

(OL) - Over land areas only

A. To be determined by reduction of real met data occurring during each quarter with freq. dist averaged in

i.e. $$(\overline{X/Q})_D \text{ Avg} = \sum_{i=1}^{16} \text{freq factor} \times (\overline{X/Q})_D \text{ real}(i)$$

$$(\overline{D/Q}) \text{ Avg} = \sum_{i=1}^{16} \text{freq factor} \times (\overline{D/Q}) \text{ real}(i)$$

TABLE M-3

Selecting the Appropriate Long Term $(\overline{D/Q})$ for Dose Calculations Involving Radioiodines & 8 D Particulates for Grass-Cow-Milk or Grass-Goat-Milk:

Type of Dose Calculation	Limiting Range	Limiting Sector	$(\overline{D/Q})$ value $1/m^2$
Release Rate-LCO	A	A	A
1/31 days-LCO	B	B	B
Quarterly-yearly LCO	B	B	B
12 consecutive month LCO	B	B	B
Semiannual Report	C	C	C

A - The worst cow or goat as per locations from land census. If no milk animal in any sector, assume a cow. at 4.5 miles in the highest $(\overline{D/Q})$ sector over land.

B - The historical $(\overline{D/Q})$ is to be a historical wind distribution frequency weighted average (see Table M-8) of all land sectors with the worst cow or goat from each sector as reported in the Land Census. A 4.5 mile cow should be assumed in the worst sector when no milk animal is reported.

C - The $(\overline{D/Q})$ is to be a wind frequency weighted average of all land sectors as reported in the Land Census. Real met data should be used for the reporting period. A 4.5 mile cow should be assumed in land sectors where no milk animal was reported.

A wind frequency weighted average is defined for land sectors (only) as

$$(\overline{D/Q})\text{ avg} = \sum_{i=1}^{16} (\text{Freq Dis factor})(\overline{D/Q})_i$$

where

$\overline{(D/Q)}_{avg}$ = the wind frequency weighted $\overline{(D/Q)}$ for all land sectors in $1/m^2$. The infant is assumed to drink milk from each animal for the wind distribution frequency.

Freq. Dis Factor = The %/100% fraction of time the wind was blowing into the sector. It is a historical determination for B above, and real for C above.

$\overline{(D/Q)}_i$ = The historical or real $\overline{(D/Q)}$ calculated for the sector over the time interval.

The historical wind frequency fractions for each sector are listed in Table M-8.

TABLE M-4

TERRAIN CORRECTION FACTORS

FLORIDA POWER AND LIGHT CO.
ST. LUCIE UNIT 1
HUTCHINSON ISLAND, FLORIDA
DAMES AND MOORE JOB NO.: 4598 - 112

TERRAIN CORRECTION FACTORS (PUFF / STRAIGHT LINE)
PERIOD OF RECORD : 8/29/77 TO 8/31/78

BASE DISTANCE IN MILES / KILOMETERS

AFTD SECT	DESIGN DIST MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.906	1.576	1.465	1.404	1.338	1.318	1.334	1.386	1.346	1.338
NE	0.	1.887	1.581	1.461	1.391	1.310	1.259	1.164	1.128	1.101	1.116
ENE	0.	1.452	1.230	1.122	1.081	1.047	1.033	.941	.941	.906	.902
E	0.	1.662	1.425	1.277	1.193	1.151	1.123	1.097	1.121	1.123	1.122
ESE	0.	1.690	1.483	1.328	1.260	1.246	1.190	1.134	1.094	1.032	.968
SE	0.	1.818	1.691	1.470	1.427	1.435	1.361	1.366	1.331	1.279	1.239
SSE	0.	1.812	1.586	1.370	1.302	1.270	1.263	1.229	1.193	1.171	1.151
S	0.	1.398	1.321	1.125	1.083	1.108	1.127	1.073	1.063	1.047	1.024
SSW	0.	1.534	1.411	1.296	1.192	1.205	1.132	1.135	1.116	1.077	1.060
SW	0.	1.685	1.492	1.294	1.233	1.200	1.222	1.160	1.160	1.198	1.196
WSW	0.	1.620	1.333	1.210	1.173	1.082	1.091	1.099	1.056	1.034	1.004
W	0.	1.651	1.415	1.290	1.218	1.154	1.099	1.081	1.067	1.093	1.083
WNW	0.	1.720	1.430	1.267	1.185	1.150	1.133	1.125	1.085	1.033	1.045
NW	0.	1.681	1.407	1.257	1.173	1.119	1.078	1.063	.995	.998	.978
NNW	0.	1.739	1.488	1.316	1.212	1.172	1.122	1.135	1.080	1.099	1.091
N	0.	1.816	1.524	1.389	1.285	1.257	1.263	1.285	1.267	1.231	1.213

TABLE M-5

HISTORICAL LONG TERM - $(\overline{X/Q})$

TERRAIN / RECIRCULATION ADJUSTED
PROGRAM ANNXOQ9 VERSION - 11/18/76
FLORIDA POWER AND LIGHT CO.
ST. LUCIE UNIT 1
HUTCHINSON ISLAND, FLORIDA
DAMES AND MOORE JOB NO.: 4598 - 112

AVERAGE ANNUAL RELATIVE CONCENTRATION (SEC./CUBIC METER)
PERIOD OF RECORD : 9/ 1/76 TO 8/31/78

BASE DISTANCE IN MILES / KILOMETERS

AFTD SECT	DESIGN DIST MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.1E-05	1.7E-06	7.8E-07	4.5E-07	3.1E-07	2.2E-07	1.7E-07	1.5E-07	1.2E-07	1.0E-07
NE	0.	1.3E-05	2.1E-06	8.9E-07	5.1E-07	3.4E-07	2.4E-07	1.7E-07	1.4E-07	1.1E-07	9.8E-08
ENE	0.	9.3E-06	1.4E-06	6.2E-07	3.7E-07	2.5E-07	1.9E-07	1.3E-07	1.1E-07	8.8E-08	7.5E-08
E	0.	9.8E-06	1.6E-06	6.5E-07	3.7E-07	2.5E-07	1.8E-07	1.4E-07	1.2E-07	9.9E-08	8.4E-08
ESE	0.	1.2E-05	1.9E-06	8.1E-07	4.8E-07	3.2E-07	2.4E-07	1.8E-07	1.4E-07	1.1E-07	9.0E-08
SE	0.	1.4E-05	2.4E-06	9.7E-07	5.7E-07	4.0E-07	2.9E-07	2.3E-07	1.9E-07	1.4E-07	1.2E-07
SSE	0.	1.1E-05	1.7E-06	7.3E-07	4.3E-07	2.9E-07	2.1E-07	1.6E-07	1.3E-07	1.1E-07	9.1E-08
S	0.	6.2E-06	1.0E-06	4.2E-07	2.5E-07	1.8E-07	1.4E-07	1.0E-07	8.0E-08	6.6E-08	5.5E-08
SSW	0.	5.7E-06	9.0E-07	4.0E-07	2.3E-07	1.6E-07	1.1E-07	8.9E-08	7.0E-08	5.7E-08	4.8E-08
SW	0.	6.1E-06	9.4E-07	3.9E-07	2.2E-07	1.6E-07	1.1E-07	8.6E-08	7.0E-08	6.0E-08	5.1E-08
WSW	0.	7.3E-06	1.1E-06	4.6E-07	2.7E-07	1.7E-07	1.3E-07	1.0E-07	8.0E-08	6.5E-08	5.4E-08
W	0.	7.6E-06	1.2E-06	5.2E-07	2.9E-07	2.0E-07	1.3E-07	1.0E-07	8.4E-08	7.2E-08	6.1E-08
WNW	0.	1.4E-05	2.1E-06	9.1E-07	5.2E-07	3.4E-07	2.6E-07	2.0E-07	1.5E-07	1.2E-07	1.0E-07
NW	0.	1.6E-05	2.4E-06	1.0E-06	5.9E-07	3.9E-07	2.8E-07	2.1E-07	1.7E-07	1.4E-07	1.2E-07
NNW	0.	1.5E-05	2.2E-06	9.6E-07	5.5E-07	3.6E-07	2.6E-07	2.0E-07	1.6E-07	1.3E-07	1.2E-07
N	0.	9.1E-06	1.4E-06	6.3E-07	3.6E-07	2.4E-07	1.8E-07	1.4E-07	1.2E-07	9.4E-08	7.9E-08

NUMBER OF VALID OBSERVATIONS = 17135
NUMBER OF INVALID OBSERVATIONS = 385
NUMBER OF CALMS LOWER LEVEL = 95
NUMBER OF CALMS UPPER LEVEL = 0

TABLE M-6

HISTORICAL LONG TERM DEPLETED - $(\overline{X/Q})_D$

TERRAIN / RECIRCULATION ADJUSTED
PROGRAM ANNX009 VERSION - 11/18/76
FLORIDA POWER AND LIGHT CO.
ST. LUCIE UNIT 1
HUTCHINSON ISLAND, FLORIDA
DAMES AND MOORE JOB NO.: 4598 - 112

AVERAGE ANNUAL RELATIVE CONCENTRATION DEPLETED (SEC/CUBIC METER)
PERIOD OF RECORD : 9/ 1/76 TO 8/31/78

BASE DISTANCE IN MILES / KILOMETERS

AFTD SECT	DESIGN DIST MI	.25 / .40	.75 / 1.21	1.25 / 2.01	1.75 / 2.82	2.25 / 3.62	2.75 / 4.42	3.25 / 5.23	3.75 / 6.03	4.25 / 6.84	4.75 / 7.64
NNE	0.	1.1E-05	1.6E-06	6.6E-07	3.8E-07	2.4E-07	1.7E-07	1.3E-07	1.1E-07	9.2E-08	7.6E-08
NE	0.	1.2E-05	1.7E-06	7.6E-07	4.3E-07	2.8E-07	1.9E-07	1.4E-07	1.1E-07	8.6E-08	7.4E-08
ENE	0.	8.9E-06	1.2E-06	5.3E-07	3.0E-07	2.0E-07	1.4E-07	1.0E-07	8.4E-08	6.6E-08	5.6E-08
E	0.	9.1E-06	1.3E-06	5.6E-07	3.1E-07	2.1E-07	1.5E-07	1.1E-07	9.1E-08	7.5E-08	6.3E-08
ESE	0.	1.2E-05	1.6E-06	6.9E-07	3.9E-07	2.6E-07	1.9E-07	1.4E-07	1.1E-07	8.5E-08	6.7E-08
SE	0.	1.3E-05	2.0E-06	8.2E-07	4.7E-07	3.3E-07	2.3E-07	1.8E-07	1.3E-07	1.1E-07	9.0E-08
SSE	0.	1.1E-05	1.6E-06	6.3E-07	3.5E-07	2.4E-07	1.8E-07	1.4E-07	1.0E-07	8.2E-08	6.8E-08
S	0.	5.9E-06	9.1E-07	3.6E-07	2.1E-07	1.4E-07	1.1E-07	7.7E-08	6.2E-08	5.0E-08	4.1E-08
SSW	0.	5.4E-06	8.0E-07	3.4E-07	1.9E-07	1.3E-07	8.9E-08	6.9E-08	5.5E-08	4.3E-08	3.6E-08
SW	0.	5.7E-06	8.4E-07	3.4E-07	1.8E-07	1.2E-07	9.2E-08	6.7E-08	5.3E-08	4.6E-08	3.8E-08
WSW	0.	7.0E-06	9.6E-07	4.0E-07	2.2E-07	1.4E-07	1.0E-07	8.0E-08	6.1E-08	5.0E-08	4.0E-08
W	0.	7.3E-06	1.1E-06	4.4E-07	2.4E-07	1.6E-07	1.1E-07	8.2E-08	6.4E-08	5.5E-08	4.4E-08
WNW	0.	1.3E-05	1.9E-06	7.9E-07	4.4E-07	2.9E-07	2.0E-07	1.6E-07	1.2E-07	9.3E-08	7.8E-08
NW	0.	1.5E-05	2.1E-06	8.9E-07	4.9E-07	3.1E-07	2.3E-07	1.7E-07	1.3E-07	1.0E-07	8.5E-08
NNW	0.	1.4E-05	2.1E-06	8.3E-07	4.5E-07	2.9E-07	2.0E-07	1.6E-07	1.2E-07	1.0E-07	8.6E-08
N	0.	8.7E-06	1.3E-06	5.4E-07	3.0E-07	2.0E-07	1.4E-07	1.1E-07	8.9E-08	7.0E-08	5.8E-08

NUMBER OF VALID OBSERVATIONS = 17135
NUMBER OF INVALID OBSERVATIONS = 385
NUMBER OF CALMS LOWER LEVEL = 95
NUMBER OF CALMS UPPER LEVEL = 0

TABLE M-7

HISTORICAL LONG TERM - $(\overline{D/Q})$

TERRAIN / RECIRCULATION ADJUSTED
PROGRAM ANNX009 VERSION - 11/18/76
FLORIDA POWER AND LIGHT CO.
ST. LUCIE UNIT 1
HUTCHINSON ISLAND, FLORIDA
DAMES AND MOORE JOB NO.: 4598 - 112

AVERAGE ANNUAL RELATIVE DEPOSITION RATE (SQUARE METER -1)
PERIOD OF RECORD : 9/ 1/76 TO 8/31/78

BASE DISTANCE IN MILES / KILOMETERS

AFTD SECT	DESIGN DIST MI	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	6.5E-08	9.3E-09	3.7E-09	2.1E-09	1.3E-09	9.0E-10	6.8E-10	5.5E-10	4.3E-10	3.5E-10
NE	0.	6.0E-08	8.9E-09	3.5E-09	1.9E-09	1.2E-09	8.1E-10	5.6E-10	4.3E-10	3.3E-10	2.8E-10
ENE	0.	3.2E-08	4.8E-09	1.9E-09	1.0E-09	6.6E-10	4.6E-10	3.2E-10	2.4E-10	1.9E-10	1.5E-10
E	0.	3.0E-08	4.6E-09	1.8E-09	9.5E-10	6.0E-10	4.2E-10	3.1E-10	2.5E-10	2.0E-10	1.6E-10
ESE	0.	3.7E-08	5.8E-09	2.3E-09	1.2E-09	8.0E-10	5.4E-10	3.9E-10	3.0E-10	2.2E-10	1.7E-10
SE	0.	6.4E-08	1.0E-08	4.0E-09	2.1E-09	1.4E-09	9.7E-10	7.2E-10	5.6E-10	4.3E-10	3.5E-10
SSE	0.	6.2E-08	9.5E-09	3.6E-09	2.0E-09	1.2E-09	8.7E-10	6.4E-10	4.9E-10	3.9E-10	3.1E-10
S	0.	4.2E-08	7.0E-09	2.6E-09	1.4E-09	9.5E-10	6.9E-10	4.9E-10	3.8E-10	3.0E-10	2.5E-10
SSW	0.	3.4E-08	5.4E-09	2.2E-09	1.1E-09	7.5E-10	5.0E-10	3.7E-10	2.9E-10	2.3E-10	1.8E-10
SW	0.	4.5E-08	7.0E-09	2.6E-09	1.5E-09	9.0E-10	6.6E-10	4.6E-10	3.6E-10	3.0E-10	2.5E-10
WSW	0.	5.3E-08	7.7E-09	3.0E-09	1.6E-09	1.0E-09	7.3E-10	5.5E-10	4.1E-10	3.3E-10	2.6E-10
W	0.	5.0E-08	7.5E-09	3.0E-09	1.6E-09	9.8E-10	6.7E-10	5.0E-10	3.8E-10	3.2E-10	2.6E-10
WNW	0.	8.8E-08	1.3E-08	4.9E-09	2.6E-09	1.7E-09	1.1E-09	8.7E-10	6.6E-10	5.1E-10	4.2E-10
NW	0.	8.2E-08	1.2E-08	4.7E-09	2.5E-09	1.6E-09	1.1E-09	7.9E-10	5.8E-10	4.7E-10	3.8E-10
NNW	0.	8.2E-08	1.2E-08	4.6E-09	2.4E-09	1.5E-09	1.1E-09	8.1E-10	5.9E-10	4.8E-10	4.0E-10
N	0.	5.1E-08	7.3E-09	2.9E-09	1.5E-09	9.8E-10	7.1E-10	5.4E-10	4.2E-10	3.2E-10	2.7E-10

NUMBER OF VALID OBSERVATIONS = 17135
NUMBER OF INVALID OBSERVATIONS = 385
NUMBER OF CALMS LOWER LEVEL = 95
NUMBER OF CALMS UPPER LEVEL = 0

TABLE M-8

JOINT WIND FREQUENCY DISTRIBUTION
DATA PERIOD: SEPTEMBER 1, 1976 - AUGUST 31, 1978

ALL WINDS
DATA SOURCE: ON-SITE
WIND SENSOR HEIGHT: 10.00 METERS
TABLE GENERATED: 12/05/78. 07.42.18.

ST. LUCIE UNIT 2
HUTCHINSON ISLAND, FLORIDA
FLORIDA POWER AND LIGHT CO.
DAMES AND MOORE JOB NO: 4598 - 112 - 27

WIND SECTOR	WIND SPEED CATEGORIES (METERS PER SECOND) 0.0-1.5	1.5-3.0	3.0-5.0	5.0-7.5	7.5-10.0	>10.0	TOTAL[1]	MEAN SPEED
NNE	71 .43	206 1.25	318 1.92	71 .43	3 .02	0 0.00	669 4.05	3.32
NE	62 .38	292 1.77	385 2.33	128 .77	0 0.00	0 0.00	867 5.25	3.43
ENE	60 .36	334 2.02	505 3.06	158 .96	0 0.00	0 0.00	1057 6.40	3.51
E	69 .42	355 2.15	510 3.09	76 .46	0 0.00	0 0.00	1010 6.11	3.25
ESE	115 .70	684 4.14	744 4.50	72 .44	1 .01	0 0.00	1616 9.78	3.04
SE	183 1.11	660 3.99	749 4.53	28 .17	0 0.00	0 0.00	1620 9.81	2.88
SSE	129 .78	579 3.50	656 3.97	93 .56	1 .01	0 0.00	1458 8.82	3.10
S	72 .44	310 1.88	407 2.46	99 .60	8 .05	1 .01	897 5.43	3.36
SSW	84 .51	372 2.25	446 2.70	105 .64	33 .20	4 .02	1044 6.32	3.48
SW	129 .78	440 2.66	336 2.03	106 .64	14 .08	0 0.00	1025 6.20	3.10
WSW	155 .94	320 1.94	186 1.13	29 .18	5 .03	0 0.00	695 4.21	2.59
W	174 1.05	267 1.62	119 .72	37 .22	2 .01	0 0.00	599 3.63	2.43
WNW	203 1.23	304 1.84	172 1.04	17 .10	0 0.00	0 0.00	696 4.21	2.34
NW	143 .87	518 3.14	424 2.57	50 .30	0 0.00	0 0.00	1135 6.87	2.85
NNW	85 .51	379 2.29	535 3.24	70 .42	1 .01	0 0.00	1070 6.48	3.22
N	91 .55	194 1.17	531 3.21	148 .90	5 .03	0 0.00	969 5.86	3.69
CALM	95 .57						95 .57	CALM
TOTAL	1920 11.62	6214 37.61	7023 42.51	1287 7.79	73 .44	5 .03	16,522 100.00	3.10

NUMBER OF VALID OBSERVATIONS 16522 94.30 PCT.
NUMBER OF INVALID OBSERVATIONS 998 5.70 PCT.
TOTAL NUMBER OF OBSERVATIONS 17520 100.00 PCT.

KEY XXX NUMBER OF OCCURRENCES
XXX PERCENT OCCURRENCES

1 - Totals below are given in hours & percent for wind frequency by sectors.

APPENDIX B

Limited Analysis Dose Assessment for Liquid Radioactive Effluents

The radioactive liquid effluents for the years 1978, 1979, and 1980 were evaluated to determine the dose contribution of the radionuclide distribution. This analysis was performed to evaluate the use of a limited dose analysis for determining environmental doses. Limiting the dose calculation to a few selected radionuclides that contribute the majority of the dose provides a simplified method of determining compliance with the dose limits of Technical Specification 3.11.1.2.

Tables B-1 and B-2 present the results of this evaluation. Table B-1 presents the fraction of the adult total body dose contributed by the major radionuclides. Table B-2 presents the same data for the Adult GI-LLI dose. The adult total body and adult GI-LLI were determined to be the limiting doses based on an evaluation of all age groups (adult, teenager, child, and infant) and all organs (bone, liver, kidney, lung, and GI-LLI). As the data in the tables show, the radionuclides Fe-59, Co-58, Co-60, Zn-65, Cs-134, and Cs-137 dominate the total body dose; the radionuclides, Fe-59, Co-58, Co-60, Zn-65, and Nb-95 dominate the GI-LLI dose. In all but one case (1979—fish, GI-LLI dose) these radionuclides contribute 90% or more of the total dose. If for 1979 the fish and shellfish pathways are combined as is done to determine the total dose, the contribution from these nuclides is 84% of the total GI-LLI dose.

Therefore, the dose commitment due to radioactive material in liquid effluents can be reasonably estimated by limiting the dose calculation to the radionuclides, Fe-59, Co-58, Co-60, Zn-65, Nb-95, Cs-134, and Cs-137, which cumulatively contribute the majority of the total dose calculated by using all radionuclides detected. This limited analysis dose assessment method is a simplified calculation that provides a reasonable evaluation of doses due to liquid radioactive effluents.

Tritium is not included in the limited analysis dose assessment for liquid releases because the potential dose resulting from normal reactor releases is negligible and is essentially independent of radwaste system operation. The amount of tritium releases annually is about 300 curies. At St. Lucie, 300 Ci/yr releases to the Atlantic Ocean produces a calculated whole body dose of 5×10^{-7} mrem/yr via the fish and shellfish pathways. This amounts to less than 0.001% of the design objective dose of 3 mrem/yr. Furthermore, the release of tritium is a function of operating time and power level and is essentially unrelated to radwaste system operation.

Table B-1

Adult Total Body Dose Contributions
Fraction of Total

	1978		1979		1980	
Radionuclide	Fish	Shellfish	Fish	Shellfish	Fish	Shellfish
Co-58	0.08	0.27	0.06	0.28	0.02	0.05
Co-60	0.05	0.19	0.03	0.15	0.20	0.44
Fe-59	0.10	0.25	0.04	0.13	0.15	0.22
Zn-65	0.01	0.10	0.02	0.19	0.04	0.20
Cs-134	0.31	0.07	0.46	0.14	0.27	0.04
Cs-137	0.42	0.10	0.38	0.11	0.30	0.04
Total	0.97	0.98	0.99	1.00	0.98	0.99

Table B-2

Adult GI-LLI Dose Contribution
Fraction of Total

	1978		1979		1980	
Radionuclide	Fish	Shellfish	Fish	Shellfish	Fish	Shellfish
Co-58	0.03	0.36	0.25	0.44	0.01	0.07
Co-60	0.02	0.23	0.12	0.22	0.05	0.57
Fe-59	0.03	0.31	0.16	0.19	0.04	0.29
Zn-65	0.01	0.02	0.01	0.05	0.01	0.04
Nb-95	0.89	0.01	0.21	0.01	0.88	0.01
Total	0.98	0.92	0.75	0.90	0.97	0.97

APPENDIX C

Technical Bases for Effective Dose Factors

Overview

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified by the use of effective dose transfer factors instead of using dose factors which are radionuclide specific. These effective factors, which are based on the typical radionuclide distribution in the releases, can be applied to the total radioactivity released to approximate the dose in the environment, ie, instead of having to sum the isotopic distribution multiplied by the isotope specific dose factor only a single multiplication (K_{eff}, M_{eff} or N_{eff}) times the total quantity of radioactive material released) would be needed. This approach provides a reasonable estimate of the actual dose while eliminating the need for a detailed calculational technique.

Determination of Effective Dose Factors

The effective dose transfer factors are based on past operating data. The radioactive effluent distribution for the past years can be used to derive single effective factors by the following equations.

$$K_{eff} = \sum_i K_i \cdot f_i \qquad \text{(C-1)}$$

where K_{eff} = the effective total body dose factor due to gamma emissions from all noble gases released

K_i = the total body dose factor due to gamma emissions from each noble gas radionuclide i released

f_i = the fractional abundance of noble gas radionuclide i is of the total noble gas radionuclides

$$(L + 1.1\,M)_{eff} = \sum_i (L_i + 1.1\,M_i) \cdot f_i \qquad \text{(C-2)}$$

where $(L + 1.1\,M)_{eff}$ = the effective skin dose factor due to beta and gamma emissions from all noble gases released

$(L_i + 1.1\,M_i)$ = the skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released

$$M_{eff} = \sum_i M_i \cdot f_i \qquad \text{(C-3)}$$

where M_{eff} = the effective air dose factor due to gamma emissions from all noble gases released

M_i = the air dose factor due to gamma emissions from each noble gas radionuclide i released

$$N_{eff} = \sum_i N_i \cdot f_i \qquad \text{(C-4)}$$

where N_{eff} = the effective air dose factor due to beta emissions from all noble gases released

N_i = the air dose factor due to beta emissions from each noble gas radionuclide i

To determine the appropriate effective factors to be used and to evaluate the degree of variability, the atmospheric radioactive effluents for the past 3 years have been evaluated. Tables C-1 and C-2 present the results of this evaluation.

As can be seen from Tables C-1 and C-2, the effective dose transfer factors varies little from year to year. The maximum observed variability from the average value is 18%. This variability is minor considering other areas of uncertainty and conservatism inherent in the environmental dose calculation models.

To provide an additional degree of conservatism, a factor of 0.8 is introduced into the dose calculation . process when the effective dose transfer factor is used. This added conservatism provides additional assurance that the evaluation of doses by the use of a single effective factor will not significantly underestimate any actual doses in the environment.

Reevaluation

The doses due to the gaseous effluents are evaluated by the more detailed calculation methods (ie, use of nuclide specific dose factors) on a yearly bases. At this time a comparison can be made between the simplified method and the detailed method to assure the overall reasonableness of this limited analysis approach. If this comparison indicates that the radionuclide distribution has changed significantly causing the simplified method to underestimate the doses by more than 20%, the value of the effective factors will need to be reexamined to assure the overall acceptability of this approach. However, this reexamination will only be needed if the doses as calculated by the detailed analysis exceed 50% of the design bases doses (ie, greater than 5 mrads gamma air dose or 10 mrads beta air dose).

In any case, the appropriateness of the A_{eff} value will be periodically evaluated to assume the applicability of a single effective dose factor for evaluating environmental doses.

Table C-1

Effective Dose Factors
Noble Gases—Total Body and Skin Doses

Year	Total Body Effective Dose Factor K_{eff} $\frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}$	Skin Effective Dose Factor $(L+1.1M)_{eff}$ $\frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}$
1978	7.3×10^2	1.4×10^3
1979	7.4×10^2	1.4×10^3
1980	5.6×10^2	1.2×10^3
Avg	6.8×10^2	1.3×10^3

Table C-2

Effective Dose Factors
Noble Gases—Air Doses

Year	Gamma Air Effective Dose Factor-M_{eff} $\frac{mrad\text{-}m^3}{\mu Ci\text{-}yr}$	Beta Air Effective Dose Factor-N_{eff} $\frac{mrad\text{-}m^3}{\mu Ci\text{-}yr}$
1978	8.0×10^2	1.2×10^3
1979	8.0×10^2	1.2×10^3
1980	6.2×10^2	1.2×10^3
Avg	7.4×10^2	1.2×10^3

APPENDIX D

Technical Bases for Eliminating Curie Inventory Limit for Gaseous Waste Storage Tanks

The NRC Standard Technical Specifications include a limit for the amount of radioactivity that can be stored in a single waste gas storage tank. This curie inventory limit is established to assure that in the event of a tank failure releasing the radioactivity to the environment the resulting total body dose at the site boundary would not exceed 0.5 rem.

For St. Lucie, the inventory limit in the waste gas storage tank has been determined to be approximately 285,000 curies (Xe-133, equivalent). An allowable primary coolant radioactivity concentration is established by the Appendix A Technical Specifications which limits the primary coolant radioactivity concentrations to 100/E with $\bar{E}$ being the average energy of the radioactivity in Mev. This equation yields an upper primary coolant gross activity limit of about 160 µCi/ml. By applying this activity concentration limit to the total liquid volume of the primary system, a total activity limit can be determined. For St. Lucie the primary system volume is about 70,000 gallons, which yields a limiting total inventory of approximately 43,000 Ci.

By assuming a typical radionuclide distribution an equivalent Xe-133 inventory can be determined. Table D-1 provides the typical radionuclide (noble gases) distribution and the Xe-133 equivalent concentration. The equivalent concentration is determined by multiplying the radionuclide concentration by the ratio of the nuclide total body dose factor to the Xe-133 total body dose factor. Summing all the individual radionuclide equivalent concentrations provides the overall reactor coolant Xe-133 equivalent concentration. The data show that the equivalent concentration is a factor of 2 larger than the gross concentration (ie, 24 µCi/gm total versus 47 µCi/gm equivalent. The resulting Xe-133 equivalent curie inventory of the reactor coolant system is approximately 86,000 Ci.

Therefore, even if the total primary system at the maximum Tech Spec allowable concentration was degassed to a single waste gas decay tank, the tank curie inventory would be well below the 285,000 Ci limit. Based on this evaluation, the curie inventory limit on a single waste gas storage tank has not been included as a Technical Specification requirement.

Table D-1

Reactor Coolant—Xe-133 Effective Concentration

Radionuclide	Reactor Coolant* Concentration (µCi/gm)	Reg Guide 1.109 Total Body DF. (mrem/yr / pCi/ml)	Ratio TB DF / Xe-133 DF.	Xe-133 Effective Concentration (µCi/gm)
Kr-85m	0.19	1.2×10^{-3}	4.1	0.78
Kr-85	0.83	1.6×10^{-5}	0.06	0.05
Kr-87	0.16	5.9×10^{-3}	20.	3.2
Kr-88	0.31	1.5×10^{-2}	52.	16.
Xe-131m	8.8	9.2×10^{-5}	0.32	2.8
Xe-133m	0.20	2.5×10^{-4}	0.86	0.17
Xe-133	12.	2.9×10^{-4}	1.0	12.
Xe-135m	0.11	3.1×10^{-3}	11.	1.2
Xe-135	1.2	1.8×10^{-3}	6.2	7.4
Xe-137	0.02	1.4×10^{-3}	4.8	0.1
Xe-138	0.12	8.8×10^{-3}	30.	3.6
Total	24.			47.

*Data adapted from the NRC GALE Code