TITLE: OFFSITE DOSE CALCULATION MANUAL REV. 6

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ODCM

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1.0 INSTRUMENTATION AND SYSTEMS

1.1 Effluent Monitoring System Description

Effluent monitor information is provided in Table 1-1, including an indication of which monitors use effluent setpoints. Figures 2-1 and 3-1 show a schematic of the possible radioactive release points which monitor locations for gaseous and liquid pathways respectively.

1.2 Setpoints

This section provides equations and methodology used for each alarm and trip setpoint on each effluent release point according to Specifications 2.1 and 2.2.

1.2.1 Setpoints for Gaseous Effluent Monitors

Setpoints for gaseous monitors are based on the permissible discharge rate as calculated in Section 3.4 of this ODCM. The most restrictive setpoints (based on annual average dose limit) should be used if practical. If not practical and with the concurrence of the Shift Supervisor and/or Superintendent of Power, as appropriate, the quarterly average, or instantaneous points may be used. (Per Reference 10, AP-11). The following discharge rates are normally utilized for alarm setpoints. Discharge rates may be determined by the methodology in Section 3.

Permissible Discharge Rate (Ci/sec)

Basis of Limit	Iodine/ Particulate*	Noble Gases
Annual Average **	1.04E-8	3.17E-3
Quarterly Average **	2.08E-8	6.34E-3
Instantaneous (Tech. Spec. 2.4.1)	1.20E-5	3.73E-2

* Half-lives greater than 8 days.

** These limits are not part of the Tech. Spec. requirement 2.4.1, but are included for information, as these limits are used for operational control of releases.

The noble gas limits are based on an isotopic mix as described in Table 3.10.

The generic equation for determining an alarm setpoint is as follows:

$$S = D/[(E)(F)(4.72E-4)]$$

Where: S = Alarm Setpoint (cpm)
D = Permissible Discharge Rate (Ci/sec)
E = Monitor Calibration Factor $\frac{(\mu Ci/cc)}{cpm}$
F = Vent Duct Flow Rate (ft^3/min)
4.72E-4 = Conversion Factor to convert from $\frac{\mu Ci}{cc}\ \frac{ft^3}{min.}$ to Ci/se

NOTE: Several effluent radiation monitors have alarm setpoints which are set directly in μCi/cc or μCi/sec.

Normally, maximum allowable limits are calculated using a standard mix as above, however setpoints may be determined based on the actual mix on a case by case basis. During normal operation, the Unit 3 main plant vent is the only significant release point. In the event another release point becomes significant, the total discharge rate for all release points must remain less than the permissible discharge rate. Alarm setpoints would be reduced accordingly, depending on the fraction of the permissible discharge rate allowed to be released from each release point.

1.2.2 Setpoints for Liquid Effluent Monitors

Liquid Effluent Monitors have setpoints based on limiting the concentrations in the discharge canal to the levels listed in 10CFR 20 Appendix B, Table 2, Column 2. The setpoints are calculated based on the following equation:

S = [(MPCw)(F)]/[(E)(f)]

S = Setpoint on Monitor (cpm)

MPCw = Maximum Permissible Concentration (μCi/cc) for isotopic mixture being released per 10CFR 20, Appendix B, Table 2, Column 2. This MPCw will be calculated for each release or an assumed isotope mixture used in the case of normally non-radioactive systems.

F = Available Dilution Flow in Discharge Canal (gpm)

f = Release Discharge Rate (gpm)

E = Calibration Factor of Monitor (μCi/cc)/cpm

NOTE: Several effluent radiation monitors have alarm setpoints which are set directly in μCi/cc or μCi/sec.

TABLE 1-1

EFFLUENT MONITORING SYSTEM DATA

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	CONTROL FUNCTIONS	ALARM SETPOINT USED*
R-12 G	Containment Gas Monitor	Samples drawn from Containment Fan Coolers #'s 32 and 35	$10-10^6$	Containment Ventilation Isolation	YES
R-24 G	Plant Vent Radiogas Monitor	In-plant vent at approximately 105' elevation	$10-10^6$ cpm 10^{-6} 10^{-3} (uCi/cc) (typical)	Secures waste gas tank release.	YES
R-27** G	Plant Vent Wide-Range Monitor	In-plant vent	10^{-7} -10^5 (uCi/cc)	Secure waste gas tank release.	YES
R-25 G	Condenser Air Ejector Monitor	In-line detector on the air ejector exhaust header	$10-10^6$ cpm	On alarm diverts air ejector flow to VC, flash evaporator shut down, steam to condenser priming ejector flow stopped.	YES
R-20 G	Waste Gas Disposal System Monitor	15' PAB-Waste Gas Tank	$10-10^5$ mR/hr	None	YES**
R-46 G	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	$10-10^6$ cpm	None	YES
R-59 G	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	10^{-7} -10^{2}****	None	YES
R-16 or R-23 L	Fan Cooler Service Water Activity	Service Water Chase across from Mini-containment	$10-10^6$ cpm	None	YES

TABLE 1-1

EFFLUENT MONITORING SYSTEM DATA

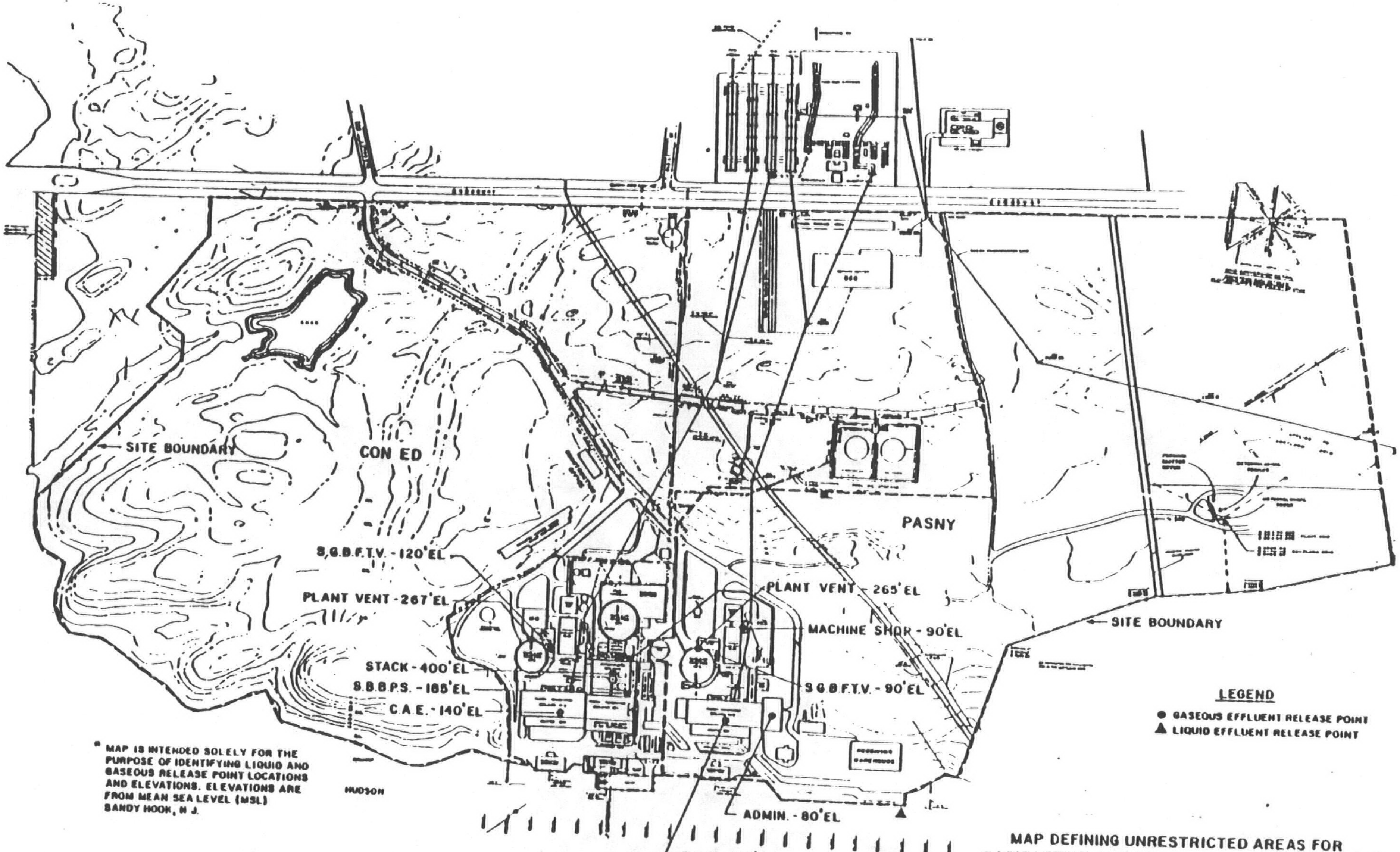
CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	CONTROL FUNCTIONS	ALARM SETPOINT USED*
R-17A or R-17B L	Component Cooling Water Activity	41' PAB in component cooling water header	$10-10^{6}$ cpm	None	YES
R-18 L	Waste Disposal Liquid Effluent Monitor	55' PAB Waste Condensate Room monitors liquid waste discharge	$10-10^{6}$	Stops release on alarm.	NO
R-19	S/G Samples Blowdown Monitor	PAB blowdown room monitors steam generator blowdown	10^{-7} -10^{2}****	Closes blowdown isolation valves.	NO

* Alarm setpoint used for effluent considerations
** If available, (R-14 or R-27 must be operating).
*** Ensures 5000 Ci limit on gas decay tanks is not exceeded.
**** Direct Reading in uCi/cc or uCi/ml
G = Gaseous
L = Liquid

NOTE ON RANGE OF MONITORS:
Maximum release rate that can be detected onscale by the detector (Ci/sec.) is based on the maximum readout range of the detector, the calibration factor and the volume flow rate of the discharge.

Ci/sec (max) = (max cpm) x (uCi/cc/cpm) x (cfm) x (4.72 E-04)
4.72E-4 is a conversion factor from $\frac{\text{uCi ft}^3}{\text{cc min}}$ to Ci/sec

FIGURE 1-1



MAP DEFINING UNRESTRICTED AREAS FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS *

FIGURE

2.0 LIQUID EFFLUENTS

2.1 Liquid Effluent Releases - General Information

2.1.1 The surveillance and lower limit of detection requirements for liquid radioactive effluents are contained in Section 3.3.1 of the Technical Specifications. Lower limit of detection calculations are listed in Appendix B. For any and ALL discharges, a minimum dilution flow should be available for IP3NPP to ensure compliance with time average liquid release limits.

2.1.2 A completed and properly authorized Liquid Radioactive Waste Permit should be issued prior to the release of any radioactive waste from an isolated tank to the discharge canal. A permit is required for each radioactive tank to be discharged.

2.1.3 All activity determinations for liquid radioactive effluents will be performed in such a manner as to be representative of the activity released to the river.

2.1.4 The radioactivity in liquid waste tanks shall be continuously monitored during release except as allowed by 3.1 Section 2.1 of RETS. If the flowmeter is inoperable, the flow shall be estimated every four hours by difference in tank level or by discharge pump curves.

2.1.5 Prior to discharge, the radioactive waste tank contents shall be recirculated for two tank volumes. After this recirculation, and prior to discharge, a sample shall be taken and analyzed for activity with a portion of the sample set aside for composite analysis. The measured activity shall be used for calculating permissible discharge rate and the alarm setpoint for the liquid waste discharge monitor.

2.1.6 Radioactive releases of steam generator blowdown during primary-secondary leaks when released to the river should be documented on Liquid Radioactive Waste Release Permits using data supplied by the Chemistry Technician.

2.1.7 Assurance that combined liquid releases from Units 2 and 3 do not exceed Section 2.3 requirement of the RETS limits for the site are provided by administrative controls. These administrative controls are agreed to in the Memorandum of Understanding (#15) between Con Edison and the New York Power Authority concerning liquid discharge and the requirements of this document.

2.1.8 The dilution flow from Unit No. 3 should be used for calculating discharge canal concentrations during the discharge. However, by agreement with Con Edison's IP2NPP Watch Supervisor and the New York Power Authority's IP3NPP Watch Supervisor, one party can reduce or eliminate radioactive liquid waste discharge for a period of time to allow the other party to use the full site dilution flow, or a specified portion thereof, for a discharge when necessary. For time average dose calculations, allocation of dilution flow for the time period are apportioned between Unit 3 and Unit 2 per Memorandum of Understanding (#15).

2.1.9 Steam generator blowdown activity is determined by samples taken three times per week. This frequency is required by Table 4.1-2 Item 6 of Appendix A of the station's operating license. These "grab" samples of the steam generators are collected in a manner to be proportional to the rate of flow of the total steam generator blowdown. These samples are then analyzed for the various radionuclides at the frequencies specified in Table 3.3-1B of the RETS. (Further flow proportional composites are made where appropriate.) (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 4.11-1.)

2.1.10 The discharge canal flow rate is determined by the use of pump flow characteristics curves. The normal flow for condenser cooling pumps is 140,000 gpm when operating at maximum speed. During the cold weather months, the condenser cooling pumps are operating at reduced speed. This reduced flow is nominally 64,000 gpm (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.3-12).

2.1.11 Radioactivity content in outdoor tanks is to be limited to less than 10 curies. Compliance with this requirement is demonstrated by limiting the radioactive concentration in these tanks to the value which results in 10 curies when the tank is at full liquid capacity except as modified below. The radioactive concentrations for these tanks are:

<u>RWST</u>:

$$\frac{10 \text{ curies} \times 10^{6}\ \mu\text{Ci/curie}}{358{,}500 \text{ gals} \times 3785 \text{ ml/gal}} = 7.3 \times 10^{-3}\ \mu\text{Ci/ml}$$

<u>PWST</u>:

$$\frac{10 \text{ curies} \times 10^{6}\ \mu\text{Ci/curie}}{165{,}000 \text{ gals} \times 3785 \text{ ml/gal}} = 1.6 \times 10^{-2}\ \mu\text{Ci/ml}$$

<u>31 & 32 MT</u>:

$$\frac{10 \text{ curies} \times 10^{6}\ \mu\text{Ci/curie}}{11{,}750 \text{ gals} \times 3785 \text{ ml/gal}} = 2.2 \times 10^{-1}\ \mu\text{Ci/ml}$$

<u>Outside Temporary Tanks</u>:

$$\frac{10 \text{ curies} \times 10^{6}\ \mu\text{Ci/curie}}{\text{Volume in gals} \times 3785 \text{ ml/gal}} = \mu\text{Ci/ml}$$

The refueling water storage tank has the potential to be filled from the reactor cavity with liquid which exceeds the limits stated. Therefore, prior to filling the RWST from the reactor cavity after refueling operations, the reactor cavity (or residual heat removal system) must be sampled for radioactivity and action taken to ensure that the total activity in the tank does not exceed 10 curies.

Outside temporary tanks should not be filled with liquid which could exceed the concentration limit calculated. Therefore, prior to transfer to outside tanks, the source of liquid shall be sampled for radioactivity. If it exceeds the concentration limit calculated, action shall be taken to ensure that the total activity in the tank does not exceed 10 curies (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.11.1.4).

2.1.12 There are no continuous composite samples for steam generator blowdown. The method of determining release concentrations is indicated below:

Blowdown flow rate to the river (by flowmeter or by flow curves) multiplied by sample blowdown concentration equals composite activity being released. In addition, R-19 monitors the composite steam generator blowdown released (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.3-12).

2.1.13 The service water radioactivity monitor listed in Table 2.1-1 (RETS) is defined as the process radiation monitors which monitor components which discharge into or are cooled by the service water system. These process radiation monitors are component cooling radiation monitor (R-17 A or B), Liquid Waste Release Monitor (R-18), Steam Generator Blowdown Monitor (R-19), Vapor Containment Fan Coolers and Vapor Containment FCU Motor Coolers (R-16 or 23).

If all monitors on the effected release path are taken out of service and the removal of that monitor from service is not specifically addressed in the Radiological Environmental Technical Specification, samples shall be taken every 12 hours or releases may not continue via this pathway. Samples may be taken on the affected monitored stream or on the service water system (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.3-12).

2.1.14 Liquid effluent concentrations are limited to 10CFR20 limits, as calculated under 20.106a. This permits averaging of effluent concentrations over one year. This is appropriate since doses from the liquid pathway are the result of total curies released and are not greatly influenced by instantaneous concentrations. In any case, the total dose per quarter and per year must be within the limitations of 2.3.2 of the RETS (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.11.1.1).

2.1.15 There are no drinking water intakes within 3 miles of the site on the Hudson River (see Section 2.4.1 for further details) (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.11.1.2).

2.1.16 A turbine hall drain system which would collect leakage of contaminated secondary plant waters during operation does not exist at IP3. The sumps which are present in the turbine hall five foot elevation receive drains from areas containing secondary plant components at sub-atmospheric pressures. These sumps would not meet the intent of the NUREG 0472.

The activity released to the environment via this pathway is negligible when steam generator blowdown activity is less than 3E-5 uCi/cc. Activity released via this pathway when steam generator activity exceeds 3E-5 uCi/cc is determined by the following method:

Turbine Hall Drain Effluent Activity = Feedwater Specific Activity x [Steam Plant Makeup Rate - Steam Generator Blowdown to the River]

(Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.3-12)

2.1.17 Carbon 14 is released at a rate of .07 curies per GW(e).yr with an average make up rate of 0.5 gal/min based upon studies performed by the New York State Department of Health. The estimate of Carbon 14 releases are included in the Radiological Impact on Man section of the Semi-annual Radioactive Effluent Release Report. These estimates are not included in dose calculations for routine releases.

2.1.18 The condensate polisher regenerant waste is routinely analyzed for radioactivity and is normally a non-radioactive release point. The monitoring program for this release point is consistent with the direction set forth in NRC IE Bulletin 80-10 "Contamination of Non-radioactive Systems and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment". Should the system become radioactive, releases from this system will be in accordance with the requirements for batch waste release tanks listed in the RETS.

2.2 Liquid Effluent Concentrations

2.2.1 This section provides a description of the means that will be used to demonstrate compliance with Technical Specification 2.3.1.

2.2.2 Compliance with the instantaneous limits of 10CFR20 is achieved by observance of discharge limits and monitor setpoints. Normally for the instantaneous releases, only dilution water from Unit 3 circulators is taken credit for except as allowed by the Memorandum of Understanding between NYPA and Con Edison. A monthly report is issued which summarizes the radioactive releases from the site for the preceding month. This report provides information necessary to comply with quarterly and annual average limitations on discharge.

2.2.3 Each isolated liquid waste tank must be recirculated for two tank volumes prior to sampling in order to obtain a representative sample.

2.2.4 The concentration in liquid effluents prior to dilution in the discharge canal is determined by sampling prior to release for batch releases. For continuous releases, the concentration is determined by grab sampling or by the process radiation monitors. For non-direct reading monitors, the following calculation is used.

$$C = E \times R$$

C = Concentration of liquid effluent (uCi/cc) prior to dilution.

E = Calibration factor of monitor $\frac{(uCi/cc)}{cpm}$

R = Count rate of monitor (ncpm)

2.2.5 The concentration in liquid effluents after dilution in the discharge canal is determined by the following equation:

$$CD = \frac{C \times f}{F}$$

CD = Diluted concentration of liquid effluent (uCi/cc)

f = Release Discharge Rate (gpm)

F = Dilution Flow in Discharge Canal (gpm)

2.3 Liquid Effluent Dose Calculation Requirements

2.3.1 Section 2.3.2 of the Technical Specification requires that the dose or dose commitment above background to an individual in an unrestricted area from radioactive materials in liquid effluents released from each reactor unit shall be limited:

a) During any calendar quarter: Less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ.

b) During any calendar year: Less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

NOTE: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech. Spec. 2.6.B.

2.3.2 Section 2.3.3 of the Technical Specifications requires that appropriate portions of the radwaste treatment system be used to reduce the radioactive material in liquid waste prior to their discharge when the projected dose due to liquid effluent from each reactor unit when averaged over 31 days, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ. Doses due to liquid release shall be projected at least once per 31 days.

These doses are projected based on the dose methodology in Section 2.4. or 2.5. The average of previous months' doses is used to project future dose.

2.3.3 Section 2.3.1 of Technical Specifications require that the concentration of radioactive material released from the site shall be limited to the concentrations specified in 10CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases (averaged per 10CFR20.106a). For dissolved or entrained noble gases the concentration shall be limited to 2E-4 uCi/ml total activity.

2.3.4 <u>Calculation of Maximum Permissible Concentrations in Liquid Effluents</u>

2.3.4.1 This section describes the methodology used to meet the requirements of Section 2.3. The total discharge canal concentration of discharge from all reactor units, both continuous and intermittent, must be maintained at less than the effective maximum permissible concentration for the respective radionuclide mixture exclusive of dissolved noble gases when averaged per 10CFR20.106a. The dissolved noble gas limit is contained in Section 2.3.3.

2.3.4.2 The following methodology is utilized to meet the requirements of Section 2.3:

a) Assure that at least two tank volumes have been recirculated as follows:

$$T = \frac{2V}{G}$$

<u>Where</u>:

T = Minimum recirculation time minutes)

V = Volume in tank (gallon)

G = Recirculation rate (gpm)

The end time is equal to T plus start time.

b) After recirculation, have the tank sampled and determine the radioactive concentration and MPCw for the sample (per Section 2.3.3).

c) Determine if other liquid radioactive discharges are being made from this unit and obtain the radioactive concentration and discharge rate. If another release is occurring, the available dilution flow must be adjusted. This may be performed by allocation or by calculation. The adjusted dilution flow is calculated as follows:

$$\frac{Dr(A)}{MPCwA} = E$$

Where:

Dr = Current release discharge rate (gpm)

E = Required dilution flow for current release (gpm)

A = Concentration of radioactivity in current release (μCi/ml)

MPCwA = Maximum permissible concentration for current release (μCi/ml)

B, the Adjusted Dilution Flow = Available Dilution Flow - E.

d) Calculate the permissible radioactive discharge rate for the isolated tank as follows:

$$D = \frac{(MPCwt) \times (B)}{C}$$

Where:

D = Maximum permissible discharge rate (gpm)

MPCwt = Maximum permissible concentration for tank release (μCi/ml)

B = Adjusted dilution flow available from unit (gpm)

C = Radioactive concentration in tank for discharge (μCi/ml)

2.4 Dose Methodology (Computer Calculation)

2.4.1 NUREG 0133 (Ref. 1, Section 4.3, Pg. 14) states that cumulative dose contributions should consider the dose contribution from the maximum exposed individual's consumption of fish, invertebrates, and potable water as appropriate. The river at IP3NPP is considered to be fresh water when in reality it is a tidal estuary and never completely fresh. Observed average chlorosity at IP3NPP has ranged as high as 2.5 g/l or about 13% sea water and 87% fresh water. Hence, use of the Hudson River for water supply purposes is precluded south of Chelsea (mile point 65) which is the nearest point of potable water supply. Radionuclide concentrations in the nearest water supply have been calculated (Ref. 2) to be a factor of at least 500 lower than the river water in the Indian Point area. Exposures from ingestion of drinking water is therefore negligible.

Based on these factors, potable water consumption is not considered to be a pathway at IP3NPP. Thus, at IP3NPP, the cumulative dose considers only the dose contributions from the maximum exposed individuals consumption of fish and invertebrates. Also, IP3NPP takes the position that the adult is the maximum exposed individual, as recommended by NUREG 0133 (Ref. 1, Section 4.3, Pg. 14). Subsequently, tables of dose factors for the adult case were developed in Section 2.4.3.

2.4.2 The relationships and methods that form the calculational base for dose accounting for the liquid effluent pathway are described in this section. These relationships can be used to meet the calculational requirements of Section 2.3.1. The cumulative dose factors (AiT) are calculated in Section 2.4.3. The following equation is generally applicable and can be used for any number of isotopes released over any time period. The equation for D(T) is to be summed over all i nuclides:

D(T) = (AiT) x [the sum from k=1 to m of (dtk)(Cik)(Fk)]

<u>Where</u>:

D(T) = The cumulative dose commitment to the total body or any organ, T, from the liquid effluents for the total time period equal to the sum from k=1 to m of dtk, in mrem.

dtk = The length of the kth time period over which Cik and Fk are averaged for all liquid releases, in hours.

Cik = The average concentration of radionuclide, i, in undiluted liquid effluent during time period dtk from any liquid release, in μCi/ml.

AiT = The site related ingestion dose commitment factor to the total body or any organ for each IP3NPP identified principal gamma and beta emitter listed in Table 2-1, in mrem-ml per hr - μCi.

Fk = The near field average dilution factor for Cik during any liquid effluent releases. Defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters.

The term Cik is the composite undiluted concentration of radioactive material in liquid waste at the release point as determined by the radioactive liquid waste sampling and analysis program as contained in the Technical Specifications. All dilution factors beyond the sample point are included in the Fk and AiT terms.

The term Fk is a near field average dilution factor and is determined as follows:

$$Fk = \frac{\text{Liquid Radioactive Waste Flow}}{[\text{Discharge Structure Exit Flow x (Applicable Factor)}]}$$

The liquid radioactive waste flow is the flow from all continuous and batch radioactive effluent releases specified in Technical Specifications from all liquid radioactive waste management systems. The discharge structure exit flow is the average flow during disposal from the discharge structure release point into the receiving body of water. Based on studies by New York University Medical Center (ref. 14 page 7). the appropriate "Applicable Factor" is 5.

In order to accurately determine Fk, it is calculated based on actual dilution flow from its site for the time period considered. This affords a quantitative assessment of radiation dose resulting from liquid effluent releases at IP3NPP. The determination and use of dilution factors is discussed in Section 2.2.

2.4.3 Dose Factor for Liquid Effluent Calculations

2.4.3.1 The equation for dose from liquid effluents requires the use of a dose factor AiT for each nuclide, i, which embodies the dose factors, pathway transfer factor, pathway usage factors, and dilution factors for the points of pathway origin. IP3NPP has followed the guidance of NUREG 0133 and has calculated AiT for the total body and critical organ of the maximum exposed individual (e.g. the adult). All the factors needed in the equation were obtained from Regulatory Guide 1.109 (Ref. 3) with the exception of the fish and invertebrate bioaccumulation factors (BFi and BIi) for Cesium, Niobium, Silver, and Antimony.

For Cesium a site specific factor of 224 was used instead of the 2,000 presented in Table A-1 of the Regulatory Guide for fish. Similarly, a factor of 224 was used for invertebrates instead of the Regulatory Guide value of 1000. For Silver, the fish and invertebrate factors are 2.3 and 3300, respectively. For Niobium, the fish and invertebrate factors are 300 and 100 respectively. For Antimony, the fish and invertebrate factors are 1 and 300 respectively. The justification for these substitutions is discussed in Section 2.5.3. The summary dose factor is as follows:

$$AiT = K[(UF)BFi + (UI)BIi]DFi$$

Where:

AiT= Composite dose parameter for the total body or critical organ for nuclide, i, for all appropriate pathways, mrem/hr per μCi/ml.

K = Units conversion factor, 1.14E05 = (1E6pCi/μCi) (1E3ml/kg) / 8760 hr/yr

UF = 21 kg/yr adult fish consumption from Table E-5 of Regulatory Guide 1.109

BFi= Bioaccumulation factor for nuclide, i, in fish pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

UI = 5 kg/yr adult invertebrate consumption from Table E-5 of Regulatory Guide 1.109.

BIi= Bioaccumulation factor for nuclide, i, in invertebrates, pCi/kg per pCi/l from Table A-1 of Regulatory Guide 1.109.

DFi= Dose conversion factor for nuclide, i, for adults in pre-selected organs, T, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109.

For the IP3NPP site, AiT can be expressed as:

$$AiT = 1.14E05\ (21\ BFi + 5\ BIi)\ (DFi)$$

IP3NPP has complied AiT factors for total body and various organs for the maximum exposed individual. These are included as Table 2-1. For completeness, this table includes all isotopes found in Reg Guide 1.109, however, several isotopes listed are not routinely identified at IP-3. In addition, the values for Antimony, Silver, Cesium, and Niobium are site specific as previously discussed.

2.5 Backup Dose Methodology (Hand Calculation)

2.5.1 This method is a simplified version of that presented in Section 2.4. and is more amenable to manual calculation. However, doses calculated using this method will normally be used only as a backup to the method of Section 2.4.

2.5.2 This method is identical to that presented in Section 2.4 except that the number of nuclides considered in the dose calculation is reduced to a number that is more manageable for manual calculations. The pathways of concern are fish and invertebrate consumption.

Review of past release data indicates that there are a group of radionuclides that are released most frequently. These radionuclides make up at least 95% of the calculated dose for a release. The equation in Section 2.4.2 will be utilized to calculate doses resulting from liquid releases by calculating the dose commitment to each organ and the total body for these major contributors. To ensure conservative calculated doses, the results of equation 2.4.2 will be multiplied by a factor of 1.1.

Isotopes to be Used for Hand Calculation

H-3*	Fe-59
Fe-55*	Nb-95
Ni-63*	Ag-110m
Mn-54	I-131
Co-58	Cs-134
Co-60	Cs-137

*Using estimated concentrations

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2.5.3 As stated in Section 2.4.3 the bioaccumulation factor (BFi) for Cesium in fish is assumed to be 224 instead of the 2000 listed in Regulatory Guide 1.109 (Ref. 3). This is based on the fact that the Hudson River at IP3NPP is not completely fresh, the Biaccumulation Factor for salt water is 40 (Ref. 2), and that the behavior of Cesium in the Hudson is a complex phenomenon.
Similarly, the bioaccumulation factor for invertebrates is 224.

The NYU Study (Ref. 2) shows that Cesium concentrations in fish are regulated at a relatively constant value independent of the concentration of Cesium in water, and the bioaccumulator factors are thus inversely proportional to the water concentration of Cesium. This explains the lower bioaccumulation factor for Cesium reported by numerous investigators for salt water fish as opposed to fresh water fish because of the higher stable Cesium content of sea water. The NYU Report states that water at Indian Point has a dissolved Cesium concentration which is much higher than would be expected from simple mixing between sea water and fresh water and postulates that these higher concentrations result from leaching of Cesium from bottom sediment by saline water.

Use of the bioaccumulation factors of Regulatory Guide 1.109 for a fresh water site will thus substantially overestimate fish ingestion doses because no account is taken of the phenomena just discussed. However, radiocesium concentrations in fish may still be estimated through the use of a bioaccumulation factor, provided that this factor is determined from the body of water of interest. This factor has been estimated (Ref. 12, page 33) to be about 224 for the flesh of indigenous fish caught in the Indian Point area. In contrast, the Cesium fresh water bioaccumulation factor presented by Regulatory Guide 1.109 for fish is 2000. Fish ingestion doses would therefore be overestimated by a factor of 13 if the Regulatory Guide value were used.

Similarly for invertebrates, the site specific bioaccumulation factor of 224 is used. This is larger than the value of 25 given in Reg. Guide 1.109 for salt water invertebrates.

A second conservatism in the NRC model concerns the location at which the concentrations in the river of the discharged Cesium are evaluated. Use of this model implies that these fish have grown directly in such a location prior to being caught, which is unrealistic and adds about a factor of five in conservation. This conservatism remains in the calculation, thus the use of the NYU (Ref. 12) bioaccumulation factor is justifiable since this remains as a conservative calculation.

No bioaccumulation factor for Silver is listed in Rev. 1 of Regulatory Guide 1.109, Table A-1. The values of 2.3 and 3300 for fish and invertebrates were obtained from ERDA publication 660 (March 1976), Oak Ridge National Laboratories and are included in the ODCM in the interests of increased accuracy since Ag110m is a potential component of IP3NPP liquid releases.

International Atomic Energy Agency Report No. 57 provides data more recent than that presented in Regulatory Guide 1.109 for niobium bioaccumulation factors. The factor in the Regulatory Guide appears to be substantially overconservative and, therefore, the more recent IAEA information is incorporated into the dose calculation methodology for liquid releases of radioniobium. The values from Table XVII of IAEA No. 57 are 300 and 100 for freshwater fish and marine invertebrates respectively and are incorporated into this ODCM.

Antimony isotopes are not listed in Reg. Guide 1.109. As for Niobium above, IAEA Report No. 57 was used to provide bioaccumulation factors for the Antimony isotopes in Table 2-1. Dose factors were calculated for Antimony as per Reference #13.

In summary, with the exception of the bioaccumulation factors discussed above, all remaining factors are as follows: fish factors are for fresh water and invertebrate factors are for salt water.

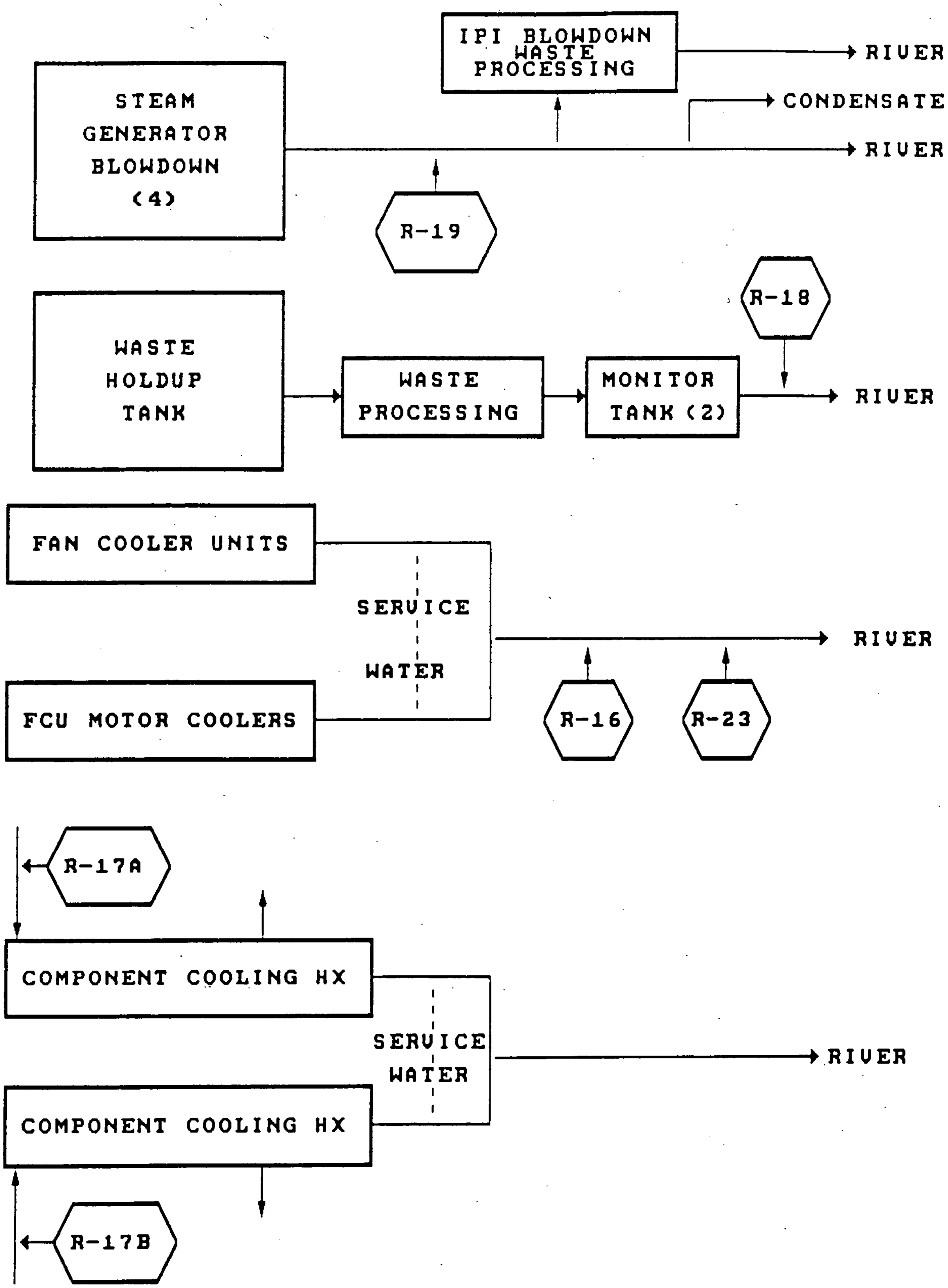
TABLE 2-1
SITE RELATED INGESTION DOSE COMMITMENT FACTOR
(FRESHWATER FISH AND SALTWATER INVERTEBRATE CONSUMPTION)
(A_iT)
mR/hr per μCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01	2.82E-01
C-14	3.35E+04	6.71E+03	6.71E+03	6.71E+03	7.67E+03	6.71E+03	6.71E+03
Na-24	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02	4.07E+02
P-32	4.95E+07	3.08E+06	1.91E+06	0.00E+00	0.00E+00	0.00E+00	5.57E+06
Cr-51	0.00E+00	0.00E+00	4.31E+00	2.57E+00	9.49E-01	5.71E+00	1.08E+03
Mn-54	0.00E+00	5.42E+03	1.03E+03	0.00E+00	1.61E+03	0.00E+00	1.66E+04
Mn-56	0.00E+00	1.36E+02	2.42E+01	0.00E+00	1.73E+02	0.00E+00	4.35E+03
Fe-55	3.20E+04	2.21E+04	5.16E+03	0.00E+00	0.00E+00	1.23E+04	1.27E+04
Fe-59	5.05E+04	1.19E+05	4.55E+04	0.00E+00	0.00E+00	3.32E+04	3.96E+05
Co-58	0.00E+00	5.14E+02	1.15E+03	0.00E+00	0.00E+00	0.00E+00	1.04E+04
Co-60	0.00E+00	1.48E+03	3.26E+03	0.00E+00	0.00E+00	0.00E+00	2.77E+04
Ni-63	4.96E+04	3.44E+03	1.67E+03	0.00E+00	0.00E+00	0.00E+00	7.18E+02
Ni-65	2.02E+02	2.62E+01	1.20E+01	0.00E+00	0.00E+00	0.00E+00	6.65E+02
Cu-64	0.00E+02	9.07E+01	4.26E+01	0.00E+00	2.29E+02	0.00E+00	7.73E+03
Zn-65	1.61E+05	5.13E+05	2.32E+05	0.00E+00	3.43E+05	0.00E+00	3.23E+05
Zn-69	3.43E+02	6.56E+02	4.56E+01	0.00E+00	4.26E+02	0.00E+00	9.85E+01
[illegible]83	0.00E+00	0.00E+00	4.05E+01	0.00E+00	0.00E+00	0.00E+00	5.83E+01
[illegible]-84	0.00E+00	0.00E+00	5.25E+01	0.00E+00	0.00E+00	0.00E+00	4.12E-04
Br-85	0.00E+00	0.00E+00	2.16E+01	0.00E+00	0.00E+00	0.00E+00	1.01E-15
Rb-86	0.00E+00	1.01E+05	4.72E+04	0.00E+00	0.00E+00	0.00E+00	2.00E+04
Rb-88	0.00E+00	2.90E+02	1.54E+02	0.00E+00	0.00E+00	0.00E+00	4.01E-09
Rb-89	0.00E+00	1.92E+02	1.35E+02	0.00E+00	0.00E+00	0.00E+00	1.12E-11
Sr-89	2.56E+04	0.00E+00	7.36E+02	0.00E+02	0.00E+00	0.00E+00	4.11E+03
Sr-90	6.31E+05	0.00E+00	1.55E+05	0.00E+00	0.00E+00	0.00E+00	1.82E+04
Sr-91	4.72E+02	0.00E+00	1.91E+01	0.00E+00	0.00E+00	0.00E+00	2.25E+03
Sr-92	1.79E+02	0.00E+00	7.74E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+03
Y-90	6.06E+00	0.00E+00	1.63E-01	0.00E+00	0.00E+00	0.00E+00	6.42E+04
Y-91M	5.73E-02	0.00E+00	2.22E-03	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Y-91	8.88E+01	0.00E+00	2.37E+00	0.00E+00	0.00E+00	0.00E+00	4.89E+04
Y-92	5.32E-01	0.00E+00	1.56E-02	0.00E+00	0.00E+00	0.00E+00	9.32E+03
Y-93	1.69E+00	0.00E+00	4.66E-02	0.00E+00	0.00E+00	0.00E+00	5.35E+04
Zr-95	1.63E+00	5.22E-01	3.53E-01	0.00E+00	8.19E-01	0.00E+00	1.65E+03
Zr-97	8.99E-02	1.81E-02	8.29E-03	0.00E+00	2.74E-02	0.00E+00	5.62E+03
Nb-95	4.82E+00	2.68E+00	1.44E+00	0.00E+00	2.65E+00	0.00E+00	1.63E+04
Mo-99	0.00E+00	1.28E+02	2.43E+01	0.00E+00	2.89E+02	0.00E+00	2.96E+02
Tc-99M	1.59E-02	4.50E-02	5.73E-01	0.00E+00	6.83E-01	2.20E-02	2.66E+01
Tc-101	1.64E-02	2.36E-02	2.31E-01	0.00E+00	4.24E-01	1.20E-02	7.09E-14
Ru-103	1.01E+02	0.00E+00	4.73E+01	0.00E+00	4.19E+02	0.00E+00	1.28E+04
Ru-105	9.15E+00	0.00E+00	3.61E+00	0.00E+00	1.18E+04	0.00E+00	5.59E+03
Ru-106	1.63E+03	0.00E+00	2.07E+02	0.00E+00	3.15E+03	0.00E+00	1.06E+05
Ag-110M	3.02E+02	2.79E+02	1.66E+02	0.00E+00	5.49E+02	0.00E+00	1.14E+05
Sb-122	3.47E+01	7.98E-01	1.20E+01	5.28E-01	0.00E+00	2.08E+01	1.32E+04
[illegible]124	4.86E+02	9.19E+00	1.91E+02	1.18E+00	0.00E+00	3.78E+02	1.38E+04
[illegible]125	3.10E+02	3.47E+00	7.39E+01	3.16E-01	0.00E+00	2.39E+02	3.42E+03

TABLE 2-1
SITE RELATED INGESTION DOSE COMMITMENT FACTOR
(FRESHWATER FISH AND SALTWATER INVERTEBRATE CONSUMPTION)
(A_iT)
mR/hr per μCi/ml

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
Te-125M	2.72E+03	9.85E+02	3.64E+02	8.18E+02	1.11E+04	0.00E+00	1.09E+04
Te-127M	6.87E+03	2.46E+03	8.37E+02	1.76E+03	2.79E+04	0.00E+00	2.30E+04
Te-127	1.12E+02	4.01E+01	2.41E+01	8.27E+01	4.55E+02	0.00E+00	8.81E+03
Te-129M	1.17E+04	4.35E+03	1.85E+03	4.01E+03	4.87E+04	0.00E+00	5.87E+04
Te-129	3.19E+01	1.20E+01	7.76E+00	2.45E+01	1.34E+02	0.00E+00	2.40E+01
Te-131M	1.76E+03	8.58E+02	7.15E+02	1.36E+03	8.70E+03	0.00E+00	8.52E+04
Te-131	2.00E+01	8.35E+00	6.31E+00	1.64E+01	8.76E+01	0.00E+00	2.83E+00
Te-132	2.56E+03	1.65E+03	1.55E+03	1.83E+03	1.59E+04	0.00E+00	7.82E+04
I-130	4.87E+01	1.44E+02	5.67E+01	1.22E+04	2.24E+02	0.00E+00	1.24E+02
I-131	2.68E+02	3.83E+02	2.20E+02	1.26E+05	6.57E+02	0.00E+00	1.01E+02
I-132	1.31E+01	3.50E+01	1.22E+01	1.22E+03	5.57E+01	0.00E+00	6.57E+00
I-133	9.15E+01	1.59E+02	4.85E+01	2.34E+04	2.78E+02	0.00E+00	1.43E+02
I-134	6.83E+00	1.86E+01	6.63E+00	3.21E+02	2.95E+01	0.00E+00	1.62E-02
I-135	2.85E+01	7.47E+01	2.76E+01	4.93E+03	1.20E+03	0.00E+00	8.44E+01
Cs-134	4.13E+04	9.83E+04	8.03E+04	0.00E+00	3.18E+04	1.06E+04	1.72E+03
Cs[illegible]6	4.32E+03	1.71E+04	1.23E+04	0.00E+00	9.49E+03	1.30E+03	1.94E+03
C[illegible]	5.29E+04	7.24E+04	4.74E+04	0.00E+00	2.46E+04	8.17E+03	1.40E+03
C[illegible]8	3.66E+01	7.24E+01	3.59E+01	0.00E+00	5.32E+01	5.25E+00	3.09E-04
Ba-139	6.46E+00	4.60E-03	1.89E-01	0.00E+00	4.30E-03	2.61E-03	1.15E+01
Ba-140	1.35E+03	1.70E+00	8.85E+01	0.00E+00	5.77E-01	9.72E-01	2.78E+03
Ba-141	3.14E+00	2.37E-03	1.06E-01	0.00E+00	2.20E-03	1.34E-03	1.48E-09
Ba-142	1.42E+00	1.46E-03	8.92E-02	0.00E+00	1.23E-03	8.26E-04	2.00E-18
La-140	1.57E+00	7.94E-01	2.10E-01	0.00E+00	0.00E+00	0.00E+00	5.83E+04
La-142	8.06E-02	3.67E-02	9.13E-03	0.00E+00	0.00E+00	0.00E+00	2.68E+02
Ce-141	3.22E+00	2.18E+00	2.47E-01	0.00E+00	1.01E+00	0.00E+00	8.33E+03
Ce-143	5.68E-01	4.20E+02	4.65E-02	0.00E+00	1.85E-01	0.00E+00	1.57E+04
Ce-144	1.68E+02	7.03E+01	9.02E+00	0.00E+00	4.17E+01	0.00E+00	5.68E+04
Pr-143	5.79E+00	2.32E+00	2.78E-01	0.00E+00	1.34E+00	0.00E+00	2.54E+04
Pr-144	1.90E-02	7.87E-03	9.64E-04	0.00E+00	4.44E-03	0.00E+00	2.73E-09
Nd-147	3.96E+00	4.58E+00	2.74E-01	0.00E+00	2.68E+00	0.00E+00	2.20E+04
W-187	2.98E+02	2.49E+02	8.70E+01	0.00E+00	0.00E+00	0.00E+00	8.15E+04
Np-239	3.53E-02	3.47E-03	1.91E-03	0.00E+00	1.08E-02	0.00E+00	7.11E+02

LIQUID RADIOACTIVE WASTE EFFLUENT SYSTEM
FLOW DIAGRAM
FIGURE 2-1



3.0 GASEOUS EFFLUENTS

3.1 Gaseous Effluent Releases - General Information

3.1.1 The surveillance and lower limit of detection requirements for gaseous radioactive effluents are contained in the Technical Specifications. Lower limits of detection calculations are addressed in Appendix B.

3.1.2 A completed and properly authorized Airborne Radioactive Waste Release Permit shall be issued prior to the release of airborne activity from the waste gas holding system and containment purge. If a containment purge exceeds 150 hours in duration then the purge will be considered a continuous, long term release for reporting purposes (See Section 3.1.16).

3.1.3 One half of the derived Ci/sec instantaneous limits delineated in Section 3.2.1 are applicable to IP3NPP since it is a two unit site. The time-average limits presented in 3.2.2, 3.2.3, and 3.2.4 are "per reactor" limits and the full dose limits are applicable to IP3.

3.1.4 During normal operations without a primary to secondary leak, almost all gaseous releases occur through the main plant vent with a negligible amount released from the Administration Building and the Radioactive Machine Shop. However, in the event of a leak, the blowdown flash tank vent and condenser air ejector releases shall be added to those from the main plant vent for the purpose of determining if total release criteria are met.

3.1.5 For releases that are expected to continue for periods over two days, a new release permit will normally be issued each day. Containment purge release permits may be terminated at the discretion of the RESS and be considered as a continuous release until the purge is terminated. However, when plant conditions change that will cause the activity in containment to significantly change, a new permit shall be issued.

3.1.6 Assurance that the combined gaseous releases from Units 2 and 3 do not exceed Section 3.2.1 limits for the site is provided by administrative controls agreed to in the Memorandum of Understanding (#16) between Con Edison and the New York Power Authority concerning gaseous effluent discharge and the requirements of the document.

3.1.7 By mutual agreement with Con Edison's IP2NPP Shift Supervisor, one unit can reduce or eliminate discharges for a period of time to allow the other unit to use the full site permissible discharge rate, or a specific portion thereof, for discharge when necessary.

3.1.8 Conservative release rate limitations have been established to aid in controlling time average dose limits. The annual average limit shall normally be used for calculating limitations on discharge. If this limitation unduly restricts an individual release, the quarterly average release rate limit (μci/sec) may be used for the release provided the quarterly time average dose limit will not be exceeded and the Operation Superintendent is in agreement. The instantaneous limit for release may be used if the Superintendent of Power is in agreement. The instantaneous limit should be checked by the Radiological and Environmental Services Department when applied.

When the instantaneous limit applies, the monitor response should be averaged over a one-hour time interval.

3.1.9 Containment Pressure Reliefs

Containment pressure reliefs occur on a frequent enough basis to be considered continuous and are sampled as part of the plant vent release path. However, to ensure that the release rate will not be exceeded, the containment noble gas monitor (R-12) and the expected flowrate are used to calculate a release rate. The effluent noble gas monitor in the plant vent is used to verify these calculations (Ref: NUREG 0472, REV.3, DRAFT 6, TABLE 3.1-13)

3.1.10 Composite Particulate Samples

One of these methods will be used to obtain a composite sample:

1. Samples will be taken weekly and integrated monthly; or

2. Samples will be taken weekly and counted together once per month. (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 4.11-12)

3.1.11 Gas Storage Tank Activity Limit

The noble gas activity limit of 50,000 Ci in the gas storage tanks was calculated using the equations from Section 5.6.1 of NUREG 0133 and the following parameters:

$Ki = 294 \frac{mrem - m^3}{\mu Ci\text{-}yr}$, Xe-133 equivalent Table B-1 Regulatory Guide 1.109

$X/Q = 1.03 \times 10^{-3}\ s/m^3$, Indian Point 3 FSAR

Qit must be calculated so that the resultant dose is less than 500 mrem in a year:

$$Qit = \frac{(500\ mrem)\ 3.15E7\ s/yr}{(1E6\ \mu Ci/Ci)(294\ \frac{mrem\ m^3}{\mu Ci\ yr})(1.03E\text{-}3\ s/m^3)} = 52,011\ Ci;\ \underline{50,000\ Ci}$$

This limit assumes 100% Xe-133 as per NUREG 133. Utilizing the Ki from an expected mixture during RCS degasification ($Ki = 787 \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr}$)

The conservative administrative limit should be 19,400 curies.

3.1.12 Gas Storage Tank Activity - Surveillance Requirements

There are two methods available to ensure that the activity in the gas storage tank is within the conservative administrative limit of 19,400 curies.

$$\frac{1.94{+}4\ Ci \times 1.E{+}6\ \mu Ci/Ci}{525\ ft^3 \times \frac{164.7\ psia}{14.7\ psia} \times 2.83E{+}4\ cc/ft^3} = 1.17E{+}2 \mu Ci/cc$$

1. Gas samples of the tank's contents which are less than 117 μCi/cc of total gaseous activity will ensure that there are less than 19,400 Ci in the tank.

2. The waste gas line monitor R-20 will have an exposure rate to activity concentration conversion factor which will also allow for activity determinations (Ref: NUREG 0472, REV 3, DRAFT 6, TABLE 3.11.2.6).

3.1.13 The ventilation flow rate utilized to monitor environmental releases from the Administrative Building Controlled Area shall be the system's design flow rate. The Administration Building system design flow rate is 12500 cubic feet per minute. Therefore, the required surveillance requirements specified in RETS table 3.2.1 are not applicable to this release pathway for this flow rate monitor.

The normal flow rate measurement for the Radioactive Machine Shop is from the installed process analyser. When the instrument is out of service, the design flow shall be used to estimate the flow rate. The design flow rate for the Radioactive Machine Shop is normally 24,750 cubic feet per minute without weld station fans. These fans are rarely operated. When all three weld station fans are operating (3000 cfm each), the total design flow rate is 33,750 cfm. The surveillance requirements of RETS Table 3.2.1, Flow Rate Monitor, do not apply when using rated fan flows.

3.1.14 The activity released via the blowdown flash tank vent is determined as follows. The release rate of radioactivity from the steam generator blowdown is determined. The partition factors for the blowdown flash tank vent as listed in Regulatory Guide 1.42 "Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases from Light Water Cooled Nuclear Power Reactors" are then applied to determine how much activity is being released via the blowdown flash tank vent (Ref: NUREG 0472, REV. 3, DRAFT 6, TABLE 3.3-13).

3.1.15 Carbon 14 is released at a rate of 9.6 curies per GW(e).yr based upon studies performed by the New York State Department of Health at Indian Point 3. This is released in a gaseous form, the primary dose from which is in the CO_2 form. Therefore, these are exempt from the dose limits specified in Sections 2.4.1, 2.4.3 and 2.4.4 of the RETS. The Carbon 14 doses resulting from these releases are calculated in accordance with the methodology in Reg. Guide 1.109 and listed in the Radiological Impact on Man section of the Semi-annual Radioactive Effluent Release Report. This calculation is performed using the fraction of carbon 14 released in the CO_2 form (26%).

3.1.16 Evaluations of previous gas decay tank and containment purge releases have been performed. These evaluations indicate that these "Short Term Releases" (less than 500 hours per year and less than 150 hours per quarter) are sufficiently random to utilize the long term meteorological dispersion factor (NUREG 0133, Section 3.3, Page 8).

3.2 Gaseous Effluent Dose Calculation Requirements

3.2.1 Section 2.4.1 of the Technical Specifications requires that the dose rate due to radioactive materials released in gaseous effluents from the site at or beyond the site boundary shall be limited to the following:

a) For noble gases: Less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin; and

b) For Iodine 131, Tritium, and for all radioactive materials in particulate form with half lives greater than 8 days: Less than or equal to 1500 mrem/yr to any organ.

The methodologies for performing these calculations are discussed in Sections 3.3.1 and 3.3.2, respectively.

3.2.2 Section 2.4.2 of the Technical Specifications requires that the air dose due to noble gases released in gaseous effluents from each reactor unit at or beyond the site boundary shall be limited to the following:

a) During any calendar quarter: Less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation.

b) During any calendar year: Less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

The methodology for calculating these doses is discussed in Section 3.3.3.

NOTE: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech. Spec. 2.6.B.

3.2.3 Section 2.4.3 of the Technical Specifications requires that the dose to a member of the general public from Iodine 131, Tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from each reactor unit shall be limited to the following:

a) During any calendar quarter: Less than or equal to 7.5 mrem to any organ; and

b) During any calendar year: Less than or equal to 15 mrem to any organ.

Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined at least once every 31 days.

The methodology for calculating these doses is discussed in Section 3.3.4.

NOTE: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech. Spec. 2.6.B.

3.2.4 Section 2.4.4 of the Technical Specifications requires that for each reactor unit, the appropriate portions of the gaseous radwaste treatment system shall be used to reduce radioactive effluents in gaseous waste prior to their discharge when projected gaseous effluent air dose at the site boundary when averaged over 31 days, would exceed 0.2 mrad for gamma radiation or 0.4 mrad for beta radiation. These doses are projected based on the dose methodology discussed in Section 3.3.3 (gas) and 3.3.4 (iodine) and the average previous months' doses are used to project future doses. The appropriate portions of the ventilation exhaust treatment system shall be used to reduce radioactive materials in gaseous releases when the projected doses averaged over 31 days, would not exceed 0.3 mrem to any organ (at nearest residence).

Dose due to gaseous release from the site shall be calculated at least once every 31 days.

3.3 Dose Methodology (Computer Calculation)

3.3.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies, the monitor response or release rate should be averaged over a one hour time interval.

3.3.1.1 The equations developed in this section are used to meet the calculational requirements of paragraph 3.2.1. The magnitude of this pathway is the same for all age groups so there is no critical group. Based on an agreement with Consolidated Edison, IP3NPP utilizes 50% of the site release limit as measured in Ci/sec which translates to 55.4% of the applicable dose rate limit for noble gas releases. Each unit has different dispersion factors due to their relative positions to the critical sector of the unrestricted area boundary. The conversion from dose rate to Ci/sec was determined with the use of a model which incorporates a finite cloud exposure correction. The methodology is discussed in Section 3.6.

A calculation showing the relationship between Ci/sec. and dose rates from Units 2 and 3 is shown in Appendix 3-A. The equations for calculating the dose rate limitations are obtained from NUREG 0133 (Ref. 1, Section 5.1). Utilizing the above assumptions, these equations reduce to the following which are to be summed for each ith nuclide. (Note Section 3.1.6 allows use of higher release rates up to the maximum of the allowable maximum permissible discharge rate.)

$$[(Ki) \times (\overline{X/Q}) \times (Qi)] = 277 \text{ mrem/yr whole body;}$$

$$[(Li + 1.1\ Mi) \times (\overline{X/Q}) \times (Qi)] = 1{,}769 \text{ mrem/yr to the skin;}$$

<u>Where</u>:

Ki = The total body dose due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ (finite cloud correction included).

Li = The skin dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per $\mu Ci/m^3$ (finite cloud correction included).

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$ (finite cloud correction included).

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per $\mu Ci/m^3$.

$\overline{Q}i$ = The release rate of radionuclides, i, an gaseous effluent for all release points in $\mu Ci/sec$.

$(\overline{X/Q})$ = For all vent releases, the highest calculated annual averaged relative concentration for any area at the unrestricted area boundary (4.85E-6 sec/m^3), in the SSW sector at 380 meters. (Note: SSW is critical IP3 sector for external gamma radiation exposure.)

The Ki, Li, Mi, and Ni factors were obtained from Table B-1 of Regulatory Guide 1.109 and are included in this document as Tables 3-4, 3-5, 3-6, and 3-7 respectively. The Ki and Mi factors have a finite cloud correction factor included.

3.3.1.2 These equations can also be expressed in the following manner:

$(\bar{K})\ (Qt)\ (\overline{X/Q})$ = mrem/yr (dose to whole body)

$(\bar{L} + 1.1\ M)\ (\overline{X/Q})\ (Qt)$ = mrem/yr dose to skin

<u>NOTE</u>: In the following formulas, the product of the ith release rate times the nuclide specific dose factor are summations over i.

<u>Where</u>:

Qt = The release rate of all noble gases summed together in μCi/sec, i.e., the sum of all Qi.

$\bar{K} = (1/Qt)\ (\bar{Q}i)\ (Ki)$

$\bar{L} = (1/Qt)\ (\bar{Q}i)\ (Li)$

$\bar{M} = (1/Qt)\ (\bar{Q}i)\ (Mi)$

$\bar{N} = (1/QT)\ (\bar{Q}i)\ (Ni)$

<u>NOTE</u>: The summations are from i to n, i being the ith nuclide.

The values of $\bar{K}$, $\bar{L}$, $\bar{M}$, and $\bar{N}$ are listed in Table 3-9 for the unrestricted area boundary.

3.3.2 Instantaneous Dose Rates - Radioiodine 131 and Particulate Releases

The equation developed in this section is used to meet the calculational requirements of Paragraph 3.2.1.b. The critical organ is considered to be the child thyroid as stated in Section 4.0 of the Technical Specifications. Based on a previous agreement with Consolidated Edison, IP3NPP utilizes 50% of the site release limit as measured in Ci/sec which translates to 67.2% of the applicable dose rate limit. This is a result of the different dispersion to the critical sector of the unrestricted area boundary. A calculation showing the relationship between Ci/sec released and dose rates from Units 2 and 3 is shown in Appendix 3-A. The equation for calculating the dose rate limitation is obtained from NUREG 0133 (Ref. 1, Section 5.2.1, Pg. 25). Utilizing the above assumptions, this equation reduces to the following where the sum of:

[(Pi) x (W) x (Qi)] must be less than 1008 mrem/yr

Where:

Pi(in) = The dose parameter for radionuclides other than noble gases for the inhalation pathway in mrem/yr per $\mu Ci/m^3$. The dose factors are based on the critical individual organ and most restrictive age group which is the child thyroid.

Qi = The release rate of radionuclide 131 and particulates, i, in gaseous effluents for all release points in $\mu Ci/sec$.

W = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to all vent releases (see Section 3.5).

W(in)= 5.21E-6 sec/m^3 for the inhalation pathway release. The location is the unrestricted area boundary in the SW sector at 350 meters.

3.3.2.1 Calculation of Pi(in): Inhalation Dose Factor

Pi (inhalation) = K' (BR) DFAi (mrem/yr per $\mu Ci/m^3$)

Where:

K' = A constant of conversion, 10^6 $pCi/\mu Ci$

BR = The breathing rate of the child age group ($3700 m^3/yr$) from Table E-5 of Regulatory Guide 1.109.

DFAi= The thyroid inhalation dose factor for the child age group for the ith radio- nuclide in mrem/pCi. Taken from Table E-9 of the Regulatory Guide 1.109. These values are reproduced in Table 3-1a.

Resolution of units yields:

Pi (inhalation) = 3.7E09 DFAi

3.3.3 <u>Time Average Dose - Noble Gas Release</u>

3.3.3.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.2 and 3.2.4. All releases at IP3NPP are assumed to be mixed mode. The magnitude for this pathway is the same for all age groups so there is no critical group. Dispersion parameters are discussed in Section 3.5.

3.3.3.2 The equation for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). The doses are evaluated at the unrestricted area boundary in the worst meteorological section (SSW sector at 380 meters). These equations reduce to the following (each equation is a summation over each ith radionuclide):

a. During any calendar quarter for gamma radiation:

(3.17×10^{-8}) Mi $[(\overline{X/Q})(Qi) + (\overline{x/q})(qi)]$, must be less than or equal to 5 mrad.

During any calendar quarter for beta radiation:

(3.17×10^{-8}) Ni $[(\overline{X/Q})(Qi) + (\overline{x/q})(qi)]$, must be less than or equal to 10 mrad.

b. During any calendar year for gamma radiation:

(3.17×10^{-8}) Mi $[(\overline{X/Q})(Qi) + (\overline{x/q})(qi)]$, must be less than or equal to 10 mrad.

(3.17×10^{-8}) Ni $[(\overline{X/Q})(Qi) + (\overline{x/q})(qi)]$, must be less than or equal to 20 mrad.

Where:

$\overline{(X/Q)}$ = The highest calculated annual average relative concentration for the unrestricted area boundary in the SSW sector at 380 meters for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16) 4.85E-6 sec/m³.

$\overline{(x/q)}$ = The relative concentration for the unrestricted area boundary for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3). This value is calculated as per Section 3.5.

Mi = The air dose factor due to gamma emission for each identified noble gas radionuclide in mrad/yr per μCi/m³.

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide in mrad/yr per μCi/m³.

qi = The average release of noble gas radionuclides in gaseous effluents, i, for short term releases (equal to or less than 500 hrs/yr or 150 hrs/qtr and not random as defined in NUREG 0133, Section 3.3) from all vents, in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

Qi = The total release of noble gas radionuclides in gaseous effluents, i, for long term releases (greater than 500 hrs/yr or 150 hrs/qtr or as noted in 3.1.16) from all vents in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

3.17×10^{-8} = The inverse of the number of seconds in a year.

The air dose factors Mi and Ni were obtained from Table B-1 of Regulatory Guide 1.109 and are listed in Table 3-6 and 3-7 respectively. The M air dose factors are finite cloud corrected.

3.3.4 Time Averaged Dose - Radioiodine 131 and Particulates

3.3.4.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.3 and 3.2.4. Only the infant and child factors need be calculated for the purpose of this manual since they are the most restrictive age groups, NUREG 0133 (Ref. 1, Section 5.3.1, Page 31).

3.3.4.2 The pathways considered in this analysis are inhalation, ground plane, vegetable ingestion, and milk ingestion. The meat ingestion pathway is not considered because of the high degree of commercial, industrial, and residential land usage in the area and the fact that this pathway was not indicated within ten miles of the plant. The inhalation, ground plane, and vegetation ingestion pathways only are assumed to exist at the nearest residence in the worst meteorological sector which is the SSW sector at 1526 meters. Since no real cow exists within 5 miles in the worst downwind sectors, all four (4) pathways will be considered at this secondary receptor. Calculated doses for the nearest resident and the secondary receptor will be compared, and the higher calculated dose will be reported.

3.3.4.3 The equations for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). These equations reduce to the following (the equations are a summation over each ith radionuclide):

During any calendar quarter:

$(3.17 \times 10^{-8})[Ri(\overline{W}\ Qi + wqi)]$ must be less than 7.5 mrem

During any calendar year:

$(3.17 \times 10^{-8})[Ri(W\ Qi + wqi)]$ must be less than 15 mrem.

Where:

Qi = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for long term releases greater than *500 hrs/yr in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

qi = The plant releases of radioiodine 131 and radioactive materials in particulate form with half-lives greater than 8 days for short term releases equal to or less than *500 hrs/yr in μCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

W = The dispersion or deposition parameter (based on meteorological data defined in Section 3.5) for estimating the dose to an individual at the controlling location for long term releases* (greater than 500 hrs/yr).

Wn(in)= The highest calculated annual average dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1526 meters, 8.96E-7 sec/m^3.

Wn(dep)= The highest calculated annual average deposition parameter for the nearest residence in the unrestricted area located in the South sector at 1279 meters, 6.14E-9 m^{-2}.

Ws(in)= The calculated annual average dispersion parameter for the inhalation pathway for the secondary receptor located in the highest downwind sectors at 5 miles, 7.22E-7 sec/m^3.

Ws(dep)= The highest calculated annual average deposition parameter for the secondary receptor located in the highest downwind sectors at 5 miles, 1.35E-9 m^{-2}.

w = The vent dispersion or deposition parameter for estimating the dose to an individual at the controlling location for short term releases *(equal or less than 500 hrs/yr) calculated as in Section 3.5.

3.17×10^{-8} = The inverse number of seconds in a year.

Ri = The dose factor for each identified pathway, organ, and radionuclide, i, in m^2 - mrem/yr per μCi/sec. or mrem/yr per $\mu Ci/m^3$. These dose factors are determined as described in Sections 3.3.4.5a-d.

* = or as defined in Section 3.1.16

3.3.4.4 Utilizing the assumptions contained in Section 3.3.4.3, these equations for the nearest resident and the secondary receptor, respectively, reduce to the following (each equation is a summation over each ith radionuclide):

$$DN = (3.17E-8) \times [Ri(I) \times [\overline{W}n(in)Qi + wn(in)qi] + (Ri(G) + Ri(V)) \times [\overline{W}n(dep)Qi + wn(dep)qi]]$$

$$DS = (3.17E-8) \times [Ri(I) \times [\overline{Ws}(in)Qi + ws(in)qi] + (Ri(G) + Ri(c) + Ri(V)) \times [\overline{Ws}(dep)Qi + ws(dep)qi]]$$

less than or equal to 7.5 mrem Quarterly

less than or equal to 15 mrem Annual

Where DN and DS is the total dose at the nearest residence and secondary receptor, respectively.

NOTE: The subscript s refers to the secondary receptor and the subscript n refers to the nearest residence.

Ri(I): Inhalation pathway factor for each ith radionuclide.

Ri(G): Ground plane pathway factor for each ith radionuclide.

Ri(v): Vegetation pathway factor for each ith radionuclide.

Ri(c): Cow milk pathway factor for each ith radionuclide.

3.3.4.5.a Calculation of Dose Factors

Calculation of Ri(I)(X/Q)Inhalation Pathway Factor

$$Ri(I)\ (X/Q) = K'[(BR)a][(DFAi)a](\text{mrem/yr per } \mu Ci/m^3)$$

Where:

K' = Constant of unit conversion, 10^6 pCi/μCi

(BR)a = Breathing rate of the receptor of age group (a) in m^3/yr.

(DFAi)a = The maximum organ inhalation dose factor for the receptor of age group (a) for the ith radionuclide in mrem/pCi. The total body is considered as an organ in the selection of (DFAi)a.

Only the child and the infant R factors are needed for the purpose of this manual since they are the most restrictive groups. The (DFAi)a values are listed in Table 3-1b, respectively.

Breathing rates:

Infant = 1400 (m^3/yr)

Child = 3700 (m^3/yr)

The values of (BR) and (DFAi)a were obtained from Tables E-5, E-9, and E-10 of Regulatory Guide 1.109.

3.3.4.5.b <u>Calculation of Ri(G)(D/Q) Ground Plane Pathway Factor</u>

$$Ri(G)\ D/Q = K'K''(SF)(DFGi)(1-\exp(-kit)) / ki \quad (m^2 \times mrem/yr \text{ per } \mu Ci/sec)$$

<u>Where</u>:

K' = A constant of conversion, 10^6 pCi/μCi.

K" = A constant of conversion, 8760 hr/yr.

ki = Decay constant for the ith radionuclide sec^{-1}.

t = The exposure time, 4.73×10^8 sec (15 years).

DFGi = The ground plane dose conversion factor for ith radionuclide (mrem/hr per pCi/m^2).

SF = Shielding factor (dimensionless) - 0.7 from Table E-15 of Regulatory Guide 1.109.

The values of DFGi were obtained from Table E-6 of Regulatory Guide 1.109. These values were used to calculate Ri(G), which is the same for all age groups and is listed in Table 3-2.

3.3.4.5.c <u>Calculation of Ri(c)(D/Q) - Grass-Cow-Milk Pathway Factor</u>

$$Ri(c)(D/Q) = [K'(QF)(Uap)(Fm)(r)(DFLi)a / (ki + kw)] \times [[fpfs/Yp + ((1-fpfs)/Ys) \exp(-kith)]\exp(-kitf)]$$

<u>Where</u>:

K' = Constant of conversion, 10^6 pCi/μCi

QF = Cow's consumption rate in kg/day (wet weight)

Uap= Receptor's milk consumption rate for age (a) in liters/yr.

Yp = Agricultural productivity by unit area of pasture grass in kg/m^2.

Ys = Agricultural productivity by unit area of stored feed in kg/m^2.

Fm = Stable element transfer coefficients in days/liters.

r = Fraction of deposited activity retained on cow's feed grass.

(DFLi)a= The maximum organ ingestion dose for the ith radionuclides for the receptor in age group (a) in mrem/pCi. Values are from Tables E-13 and E-14 of Regulatory Guide 1.109 and are listed in Table 3-3a and 3-3b.

ki = Decay constant for the radio-nuclide in sec^{-1}.

kw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day half-life).

tf = The transport time from pasture, to cow, to milk, to receptor in sec.

th = The transport time from pasture, to harvest, to cow, to milk, to receptor, in sec.

fp = Fraction of the year that the cow is on pasture.

fs = Fraction of the cow feed that is pasture grass while the cow is on pasture.

The concentration of Tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the Ri(c) is based on X/Q:

$$Ri(c)(X/Q) = K'K'''(Fm)(QF)(Uap)(DFLi)a \; 0.75(0.5/H) \text{ (mrem/yr per } \mu Ci/m^3)$$

<u>Where</u>:

K''' = A constant of unit conversion, 10^3 m/kg;

H = Absolute humidity of the atmosphere in gm/m^3;

0.75= The fraction of total feed that is water;

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

Other parameters and values are given above. The value of H may be considered as 8 grams/meter^3 (NUREG 0133, PAGE 27) in lieu of site specific information.

Ri(c) Parameters Are Taken From The Following Sources:

Parameter		Value	Table R.G. 1.109
r (dimensionless)		1.0 for radioiodine 0.2 for particulates	E-15 E-15
Fm (days/liter)		Each stable element	E-1
Uap (liters/yr)	- infant	330	E-5
	- child	330	E-5
	- teen	400	E-5
	- adult	310	E-5
(DFLi)a(mrem/pCi)		Each radionuclide	E-11 to E-14
Yp(kg/m^2)		0.7	E-15
Ys(kg/m^2)		2.0	E-15
tf (seconds)		1.73×10^5 (2 days)	E-15
tf (seconds)		7.78 x 106 (90 days)	E-15
Qf (kg/day)		50	E-15

fs *

fp *

* fs and fp are assumed to be unity.

Only the Ri(c) values for the child and the infant are calculated for the purpose of this manual as they are the most restrictive age groups. Ingestion dose factors for these two age groups are given in Tables 3-3a and 3-3b.

3.3.4.5d Calculation of Ri(V)(D/Q) - Vegetation Pathway Factor

Ri(V)(D/Q) =
[K'(r)/(Yv(ki + kw))] x (DFLi)a [(UaL)fL exp(-kitL) + (UaS)fg exp(-kith)]

Where:

k = Constant of conversion, 10^6pCi/μCi

UaL = Consumption rate of fresh leafy vegetation by the receptor in age group (a) in kg/yr.

UaS = Consumption rate of non-leafy vegetables by the receptor in age group (a) in kg/yr.

fL = The fraction of the annual intake of leafy vegetation grown locally.

fg = The fraction of the annual intake of non-leafy vegetation grown locally.

tL = The average time between harvest of leafy vegetation and its consumption in seconds.

th = The average time between harvest of stored vegetation and its consumption in seconds.

Yv = The vegetation area density in kg/m^2.

All other factors are defined in the Calculation of Grass-Cow-Milk Pathway Factor Section 3.3.4.5.c of this manual.

<u>Ri(V) Parameters Are From The Following Sources:</u>

Parameter		Value	Table R.G. 1.109
r (dimensionless)		1.0 for radioiodines 0.2 for particulates	E-15
(DFLi)a (mrem/pCi)		Each radionuclide	E-11 to E-14
UaL (kg/yr)	- infant	0	E-5
	- child	26	E-5
	- teen	42	E-5
	- adult	64	E-5
UaS (kg/yr)	- infant	0	E-5
	- child	520	E-5
	- teen	630	E-5
	- adult	520	E-5
fL (dimensionless)		1.0	E-15
fg (dimensionless)		0.76	E-15
tL (seconds)		8.6 x 104 (1 day)	E-15
th (seconds)		5.18 x 106 (60 days)	E-15
Yv (kg/m^2)		2.0	E-15

The concentration of Tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the Ri(V) is based on X/Q:

(RiV)(X/Q) = K'K'"[(UaL)fL + (UaS)fg](DFLi)a (0.75)(0.5/H) (mrem/yr per $\mu Ci/m^3$);

Where all terms have been defined above and in the grass-cow-milk pathway calculation section of this manual. (DFLi)a for the child are given in Table 3-3a.

3.4 Backup Simplified Dose Methodology

The dose calculation procedures described in this section are intended to serve as a backup only. They will be implemented whenever the computer implemented procedures cannot be followed.

3.4.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies, the process radiation monitor response or release rate should be averaged over a one-hour time interval.

3.4.1.1 This section describes the alternative calculational method to meet the requirements of Paragraph 3.2.1. The purpose of this method is to provide a calculational technique which is readily amenable to hand calculation and yields conservative results.

3.4.1.2 To determine an acceptable noble gas instantaneous release rate, a standard isotopic mixture of noble gases may be assumed. This isotopic mixture was measured for a mixture of isotopes typical of reactor coolant with exposed fuel. This requirement is evaluated at the worst sector of the unrestricted area boundary. Based on this isotopic mixture, standard Ks, Ls, Ms, and Ns (lower case s denotes a weighted sum, see Table 3-8) can be determined using the technique presented in paragraph 3.3.1.2 and Ki, Li, Mi, and Ni values from Tables 3.4-7. The data and results of this calculation are shown in Table 3-8.

3.4.1.3 The isotopic mixture chosen was obtained from a reactor coolant sample during an operating period with exposed fuel. Table 3-8 contains the mixture data and the fractional relative abundance of each isotope.

These standard factors can be used with the equations and limits presented in Section 3.3.1. The instantaneous dose rate equations then reduce to the following:

Dose to the Whole Body:

$(\overline{Ks})(\overline{X}/Q)(Qt)$ less than or equal to 277 mrem/yr

Dose to the Skin:

$(\overline{Li} + 1.1\ \overline{Ms})(\overline{X}/Q)(Qt)$ less than or equal to 1,769 mrem/yr

3.4.1.4 Utilizing the equations from Paragraph 3.4.1.3 and the values from Table 3-8, maximum release limits for all noble gases in μCi/sec can be calculated as follows:

Maximum instantaneous release rates:

$$Qt = \frac{277}{Ks(X/Q)} = \frac{277}{(1.53E+3)(4.85E-6)} = 3.73\ E+4\ \frac{\mu Ci}{sec}\ \text{(Whole Body)}$$

$$Qt = \frac{1769}{(Ls + 1.1\ Ms)(X/Q)} = \frac{1769}{3.20E+3(4.85E-6)} = 1.14E+5\ \frac{\mu Ci}{sec}\ \text{(Skin)}$$

3.4.2 Instantaneous Dose Rates-Radioiodines and Particulates

3.4.2.1 This section describes the alternative calculational method to meet the requirements of Paragraph 3.2.1. The purposes of this method is to provide a calculational technique which is readily amenable to hand calculation and yields conservative results.

3.4.2.2 To determine an acceptable iodine and particulate release rate, it is assumed that the limit on these releases shall be met if the total noble gas concentration in the VC is at least a factor of 20,000 more than the concentration of radioiodine and long lived particulates or VC iodines and long lived particulates are less than 1E-7 μCi/cc. This has historically been the case and this assures that the noble gas activity will be limiting.

3.4.2.3 The thyroid is the critical organ for gaseous releases of iodine and particulates typical of IP3NPP based on analysis performed in Ref. 4.

3.4.2.4 In performing this analysis only the child thyroid inhalation pathway at the worst annual average X/Q unrestricted area boundary sector is considered.

3.4.2.5 Iodine 131 and particulates detected are assumed to be I-131 for the purpose of these calculations which is a conservative assumption since this isotope has the highest thyroid dose factor of all iodines and particulates.

3.4.2.6 The assumptions presented in the previous paragraphs can be used with the equation presented in Section 3.3.2 to determine the instantaneous dose rate.

D = P(in) x WB(in) x Q less than or equal to 1070 mrem/yr to the child thyroid

Where:

D = The dose in mrem/yr

P(in) = The dose parameter of I-131 for the inhalation pathway, 1.62E07 mrem/yr per $\mu Ci/m^3$

WB(in) = The highest calculated annual average dispersion parameter, for the inhalation pathway at the unrestricted area boundary in the SW sector at 350 meters, 5.21E-6 sec/m^3.

NOTE: Subscript B refers to site boundary.

Q = The total plant release rate of all iodines and particulates summed together in $\mu Ci/sec$.

3.4.2.7 These equations can then be solved to yield an estimate of the maximum allowable release rate as follows:

$$Q = \frac{D}{[P(in)\ WB(in)]}\text{, where}$$

D = 1008 mrem/yr and the denominator equals mrem/yr per $\mu Ci/sec$

(See Appendix 3-A - Instantaneous Release Rate.)

$$Q = \frac{1008}{(1.62E+7)(5.21E-6)} = \frac{1008}{8.44E+1} = 12.0\ \mu Ci/sec$$

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3.4.3 Time Averaged Dose - Noble Gas Releases

3.4.3.1 This section describes the alternative method of meeting the requirements of Paragraphs 3.2.2 and 3.2.4, and the alternative method of implementing the calculation techniques presented in Section 3.3.3.

3.4.3.2 On a monthly basis, collect the analytical results of all noble gas samples required by the surveillance requirements for IP3NPP.

3.4.3.3 A value of $\bar{K}t$, $\bar{L}t$, $\bar{M}t$, and $\bar{N}t$ is determined for each release using the dispersion parameter for the site boundary in the worst sector. The calculation is as follows:

$$\bar{K}i = Ki\ (\overline{X/Q})$$

$$\bar{L}i = Li\ (\overline{X/Q})$$

$$\bar{M}i = Mi\ (\overline{X/Q})$$

$$\overline{Ni} = Ni\ (\overline{X/Q})$$

<u>Where</u>:

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$ (finite cloud correction used).

Li = The skin dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide in mrem/yr per $\mu Ci/m^3$ (finite cloud correction used).

Ni = The air dose factor due to beta emissions for each identified noble gas radio- nuclide in mrad/yr per $\mu Ci/m^3$.

$(\overline{X/Q})$ = The highest calculated annual average dispersion parameter for the noble gas pathway at the unrestricted area boundary, 4.85E-6 sec/m^3.

Determine weighted average dose factors as follows:

All values of $\overline{Ki}$, $\overline{Li}$, $\overline{Mi}$, and $\overline{Ni}$ are shown in Table 3-9 for the unrestricted area boundary.

Ct = the sum of all Ci concentrations

Each of the following expressions is summed over all ith nuclides:

Ki = (1/Ct) x (Ki x Ci)

Li = (1/Ct) x (Li x Ci)

Mi = (1/Ct) x (Mi x Ci)

Ni = (1/CT) x (Ni x Ci)

<u>Where</u>:

Ci = Concentration of isotope i ($\mu Ci/cc$) in analysis, t

Ct = Concentration of all noble gas isotopes ($\mu Ci/cc$) for a specific analysis, t

Calculate resultant doses and compare with limits:

Considering both the continuous and batch releases, determine the total weighted average M and N factors for the calendar month. Utilizing the highest calculated (X/Q) for the site boundary; add the resulting value of:

3.17 E-8 yr/s x (total uCi released) x (Mt)(X/Q) or (Nt)(X/Q),

to the appropriate values for the current calendar quarter or calendar year. Compare these sums to the limits of Sections 3.2.2 and 3.2.4 as appropriate for gamma air dose and beta air dose.

3.4.4 Time Averaged Dose - Iodine 131 and Particulates

3.4.4.1 This section describes the alternate method of meeting the requirements of Paragraphs 3.2.3 and 3.2.4 and of implementing the calculational techniques presented in Section 3.3.4.

3.4.4.2 On a monthly basis collect the analytical results of iodines and particulate samples required by the surveillance requirements for IP3.

3.4.4.3 The activity of I-131 and particulate released for each weekly sampling period, are summed together to get the total activity released for the month, prorating when time periods overlap the monthly periods. This value is then divided by the time in seconds for the month to find Qt in μCi/sec. the average release rate for the month. To simplify the calculations, all measured Iodine 131 and particulate activity (with a half-life greater than 8 days) is assumed to be I-131.

3.4.4.4 Determine the monthly dose and monthly time averaged fraction of the quarterly dose requirements in Paragraph 3.2.3. At the nearest residence the inhalation and vegetation pathways are considered. At the secondary receptor as defined in Section 3.3.4.2 the cow-milk, and inhalation pathways are considered. Because of the cow-milk pathway, the infant is considered the critical age group at the secondary receptor. At the nearest resident the child age group is critical. For both receptors the ground plane pathway is omitted because it is relatively insignificant. Incorporating these assumptions, the equations from Section 3.3.4.4 can be simplified as follows:

Child thyroid dose at the nearest residence:

Dn = [Rc(I) Wn(in) + Rc(V) Wn(dep)](Qt)(1 yr/12 months) in mrem/month.

<u>Where</u>:

Dn = Estimated dose to the nearest resident

Rc(I)= Child inhalation thyroid dose factor for I-131 = 1.62E7 mrem/yr per $\mu Ci/m^3$

Rc(V)= Child vegetation thyroid dose factor for I-131 = 4.77E10 m^2 mrem/yr per μCi/sec.

Wn(in) = X/Q at the nearest residence = 8.96E-7 s/m^3

Wn(dep) = D/Q at the nearest residence = 6.14E-9 m^{-2}

Infant thyroid dose at the secondary receptor:

DS = [RI(I)Ws(in)+((Rc(I)+Rv(I))Ws(dep))] x(Qt) x (1yr/12 months) = mrem/month

Ds = Estimated dose to the secondary receptor

RI(I) = Infant inhalation thyroid dose factor for I-131 = 1.48E7 mrem/yr per $\mu Ci/m^3$

Rc(I) = Infant cow-milk thyroid dose factor for I-131 = 1.06E12 m^2 mrem/yr per μCi/sec.

Rv(I) = Infant vegetation thyroid dose factor for I-131 = 0 (no ingestion of vegetables for infant)

Ws(in)= X/Q at the secondary receptor = 7.22E-7 s/m^3

Ws(dep)= D/Q at the secondary receptor = 1.35E-9 m^{-2}

Substituting the parameters into both equations:

Dn = 2.56E+1 Qt mrem/month

Ds = 1.20E+2 Qt mrem/month

The largest of these two dose parameters (Ds) should be used for manual dose calculations.

Compare this thyroid dose to the limits in Paragraph 3.2.4. Add this calculated thyroid dose to the calculated values for the time period in the calendar quarter and calendar year. Compare these sums to the limits of Paragraph 3.2.3. If the dose is excessive, the calculation will be performed in greater detail using the methodology described in Section 3.3.4.

3.5 Calculation of Meteorological Dispersion Factors

3.5.1 For the purpose of these calculations, the site boundary was taken to be the unrestricted area boundary. The distances to the site boundary, as measured from the plant vent on top of the IP3NPP primary containment, are shown in Table 3-11 for each of the 16 major compass sectors. The distances to the nearest residence in each of these sectors is also shown on this table. In the sectors where the Hudson River is the site boundary, the opposite shore is assumed as the boundary of the unrestricted area. This is based on the definition of unrestricted area in NUREG 0133 (Ref. 1, Section 2.2, Page 6) which states that the unrestricted area boundary does not include areas over bodies of water. The nearest opposite shore distance is five times that of the closest land restricted area boundary. Therefore, these locations are unimportant when evaluating the maximum unrestricted area boundary concentrations.

3.5.2 The atmospheric transport and diffusion model used in the evaluation of dispersion and desposition factors is the sector-average straight-line model in Regulatory Guide 1.111 (Ref. 15) for mixed-mode releases with plume-rise effects, downwash, and building-wake correction. The analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and are documented in detail in Ref. 17. Use was made of 10-years' worth of hourly meteorological data collected on site during the period 1981 through 1990 in accordance with the accuracy requirements of Regulatory Guide 1.23 (Ref. 18); the data recovery index for that period was in excess of 99%. Comparison of the new meteorological data with previous data shows no difference in the overall dispersion conditions at the site. In the analyses, wind-speed coefficients in Regulatory Guide 1.111 were used to extrapolate the measured wind speeds to the height of the main vent (on top of the primary containment). Also, the regulatory plume entrainment model was used to determine plume partitioning between ground-level and elevated releases, and no credit was taken for decay and depletion in transit. Recirculation effects were accounted for by confining in-valley flows within the valley out to a distance of 10 miles (up or down the valley) and allowing a portion of them to return to the site without additional dilution.

3.5.3 To meet the calculational requirements of Paragraphs 3.2.1, 3.2.2, and 3.2.4 the annual average dispersion factors were calculated for each compass sector at the site unrestricted area boundary. The most restrictive X/Q was determined to be 5.2E-06 s/m^3 in the SW sector at 350 meters for inhalation and the SSW sector at 380 meters with an X/Q of 4.85E-6 s/m^3 for external gamma radiation. The distances to the site boundary in each sector are listed in Table 3-9.

3.5.4 To meet the calculational requirements of Paragraph 3.2.3 iodines and particulates, the annual average deposition and dispersion parameters were calculated for the nearest residence in each of the compass sectors. Distance to the nearest residence in each sector are listed in Table 3-11. Because no real dairy exists within 5 miles of the power plant, a hypothetical cow was placed in the worst meteorological sector at 5 miles. Dispersion and deposition parameters for both locations were calculated using the models and data described in Sec. 3.5.2 above and are as follows:

Wn(in)= The highest calculated annual average dispersion parameters for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1526 meters, 8.96E-7 sec/m^3.

Wn(dep)= The highest calculated annual average deposition parameters for the ground plane and vegetation pathways for the nearest residence in the unrestricted area located in the S sector at 1279 meters, 6.14E-9 m^{-2}. For Tritium in the vegetation pathway Wn(in) is used.

Ws(in)= The calculated annual average dispersion factor for the inhalation pathway for the secondary receptor occurs in the downwind sectors at 5 miles, 7.22E-7 sec/m^3.

Ws(dep)= The highest calculated annual average deposition factor for the cow-milk vegetation, and ground plane pathways for the secondary receptor occurs in the downwind sectors at 5 miles, 1.35E-9 m^{-2}. For Tritium in the cow-milk and vegetation pathways Ws(in) is used.

3.5.5 To meet the calculational requirements of Paragraphs 3.2.2, 3.2.3 and 3.2.4 and the calculation methodologies described in Sections 3.3.4 and 3.3.3 short term release dispersion and deposition factors may need to be calculated. For this document short term release dispersion and deposition factors are determined from the long term annual average parameters. The method utilized is that presented by Sagendorf in NUREG 0324 (Ref. 5) as recommended by NUREG 0133 (Ref. 5, Section 3.3, Page 8), and makes use of a factor (F) developed for a particular compass sector and distance which is simply multiplied by the annual average dispersion or deposition parameter for the same sector and distance to develop the corresponding short-term parameter. This factor is defined as:

$$F = [NTOTAL/8760]^m$$

Where:

F = The non-dimensional correction factor used to convert annual average dispersion or deposition factors to short term dispersion or deposition factors.

NTOTAL = The total number of hours of

intermittent releases.

8760 = The total number of hours in a year.

ANMX = The calculated annual average dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest.

F15MX = The short term dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest. This is the 15th percentile value such that worse weather conditions can only exist 15% of the time and better weather conditions 85% of the time.

$$m = \frac{\log\ (ANMX/F15MX)}{\log\ (8760)}$$

The atmospheric transport and diffusion model used in the evaluation of short-term dispersion and deposition parameters (F15MX) is the Gaussian plume-centerline model in Regulatory Guide 1.145 (Ref. 19), adapted for mixed-mode releases with plume-rise effects, downwash, building-wake correction and plume meander considerations. As was the case with the annual average parameters, the analyses were carried out using the AEOLUS-3 computer code (Ref. 16) and the 10-year hourly meteorological data base; they are documented in detail in Ref. 17.

Note that, in line with the guidance in NUREG-0133 (Ref. 1, Sec. 5.3.1, page 29), short-term releases (equal to or less than 500 hours per year) are considered to be cumulative over the calendar quarter or year, as appropriate. However, from Sec. 3.1.16 of the ODCM, and in line with SEc. 3.3, page 8 of NUREG-0133, gas-decay tank releases and containment purges have been determined to be sufficiently random so as to permit use of the long-term dispersion and deposition parameters for assessment of their radiological impact.

3.5.6 The short term 15th percentile dispersion or deposition factor for use in the equation of the preceeding paragraphs and the simplified F factor equation are as follows:

a) Nearest Residence Inhalation:

F15MX (730m, E, inhalation) = 3.00E-5 sm^{-3}
ANMX (1526m, SSW, inhalation) = 8.96E-7 sm^{-3}

$$F = [NTOTAL/8760]^m; m = \frac{\log(8.96E\text{-}7/3.00E\text{-}5)}{\log\ (8760)} = -0.387$$

$$F = [NTOTAL/8760]^{-0.387}$$

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b) Nearest Residence Deposition:

F15MX (730m, E, Dep.) = 2.61E-7 m^{-2}
ANMX (1280m, S, Dep.) = 6.14E-9 m^{-2}

$$F = [NTOTAL/8760]^{m}; \quad m = \frac{\log(6.14E\text{-}9/2.61E\text{-}7)}{\log(8760)} = -0.413$$

$$F = [NTOTAL/8760]^{-0.413}$$

c) 5 Mile Inhalation:

F15MX (5 mi, Down Valley Sectors, inhal.) = 6.19E-6 sm^{-3}
ANMX (5 mi, Down Valley Sectors, inhal.) = 7.22E-7 sm^{-3}

$$F = [NTOTAL/8760]m; \quad m = \frac{\log(7.22E\text{-}7/6.19E\text{-}6)}{\log(8760)} = -0.247$$

$$F = [NTOTAL/8760]^{-0.247}$$

d) 5 Mile Deposition:

F15MX (5 mi, Down Valley Sectors, Dep) = 9.50E-9 m^{-2}
ANMX (5 mi, Down Valley Sectors, Dep) = 1.35E-9 m^{-2}

$$F = [NTOTAL/8760]^{m}; \quad m = \frac{\log(1.35E\text{-}9/9.50E\text{-}9)}{\log(8760)} = -0.215$$

$$F = [NTOTAL/8760]^{-0.215}$$

3.6 Justification for and Use of Finite Cloud Assumption for Assessing Site Boundary Dose

Two models are currently available for the computation of doses from external gamma radiation:

a) The semi-infinite cloud model, which is conservatively applicable only for ground-level releases assumes ground level airborne concentrations are the same throughout a cloud that is large in extent relative to the photon path lengths in air, and

b) The finite-cloud model, which takes into consideration the actual plume dimensions and the elevation above the receptor.

The semi-infinite cloud model (which is normally used in a variety of applications because of its simplicity) has two drawbacks:

- It could be overly conservative for receptors close to the release point (particularly for ground-level releases under stable conditions with limited plume dispersion) due to the basis that the high concentration at the receptor is assumed to exist everywhere, and

- It is not suitable for elevated releases since gamma radiation emanating from the radioactive cloud could still reach a receptor on the ground even though the plume is still aloft (i.e., even though the concentration at ground level is equal to zero).

For practical applications, it is possible to define isotope-dependent finite-cloud correction factors to express the difference in external radiation exposures between a finite cloud (which may be either at ground level or elevated) and a semi-finite cloud. Physically speaking, when such a correction factor is applied to the calculated ground-level concentration resulting from a given plume, it will define the equivalent concentration in a semi-infinite cloud which would yield the same external exposure as the finite cloud. Such a correction factor is a function of both the airborne radionuclide energy and of plume dispersion under the prevailing conditions. At distant receptors, where the plume dimensions reach limiting conditions, such correction factors reduce to unity.

The AEOLUS-3 code (which was used for the determination of the annual average dispersion and deposition parameters listed above), also has the capability of providing a basis for computation of isotope-specific finite-cloud correction factors based on the models in "Meteorology and Atomic Energy" (Ref. 20, Sec. 7.5.2). The code was used (along with the mixed-mode release option and the 10-year hourly meteorological data base) for the determination of the correction factors as would be applicable at the IP3 site boundary.

Note that the correction factors can be viewed as adjustment factors to the dose conversion factors in Regulatory Guide 1.109 (Ref. 3) for immersion in semi-infinite clouds. The nuclide specific correction factors and adjusted dose factors are presented in Table 3.4 for the IP3 site boundary.

TABLE 3-1a

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C 14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
NA 24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P 32	7.04E-04	3.09E-05	2.67E-05	NO DATA	NO DATA	NO DATA	1.14E-05
CR 51	NO DATA	NO DATA	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.00E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-06
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.83E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.93E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91M	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05

This table was taken from
NRC Regulatory Guide 1.109
Table E-9

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	5.04E-08	NO DATA	1.38E-09	NO DATA	NO DATA	2.01E-05	1.05E-04
ZR 95	5.13E-05	1.13E-05	1.00E-05	NO DATA	1.61E-05	6.03E-04	1.65E-05
ZR 97	5.07E-08	7.34E-09	4.32E-09	NO DATA	1.05E-08	3.06E-05	9.49E-05
NB 95	6.35E-06	2.48E-06	1.77E-06	NO DATA	2.33E-06	1.66E-04	1.00E-05
MO 99	NO DATA	4.66E-06	1.15E-08	NO DATA	1.06E-07	3.66E-05	3.42E-05
TC 99M	4.81E-13	9.41E-13	1.56E-11	NO DATA	1.37E-11	2.57E-07	1.30E-06
TC101	2.19E-14	2.30E-14	2.91E-13	NO DATA	3.92E-13	1.58E-07	4.41E-09
RU103	7.55E-07	NO DATA	2.90E-07	NO DATA	1.90E-06	1.79E-04	1.21E-05
RU105	4.13E-10	NO DATA	1.50E-10	NO DATA	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	NO DATA	4.57E-06	NO DATA	4.97E-05	3.87E-03	1.16E-04
AG110M	4.56E-06	3.08E-06	2.47E-06	NO DATA	5.74E-06	1.48E-03	2.71E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	NO DATA	1.29E-04	9.13E-06
TE127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
TE127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I 130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	NO DATA	1.38E-06
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	NO DATA	8.65E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
I 134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	NO DATA	2.58E-07
I 135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	NO DATA	1.20E-06
CS134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
CS136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
CS137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	NO DATA	1.68E-07	1.84E-08	7.29E-08
BA139	4.98E-10	2.66E-13	1.45E-11	NO DATA	2.33E-13	1.56E-06	1.56E-05

TABLE 3-1a CONT'D

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

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NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	2.00E-05	1.75E-08	1.17E-06	NO DATA	5.71E-09	4.71E-04	2.75E-05
BA141	5.29E-11	2.95E-14	1.72E-12	NO DATA	2.56E-14	7.89E-07	7.44E-08
BA142	1.35E-11	9.73E-15	7.54E-13	NO DATA	7.87E-15	4.44E-07	7.41E-10
LA140	1.74E-07	6.08E-08	2.04E-08	NO DATA	NO DATA	4.94E-05	6.10E-05
LA142	3.50E-10	1.11E-10	3.49E-11	NO DATA	NO DATA	2.35E-06	2.05E-05
CE141	1.06E-05	5.28E-06	7.83E-07	NO DATA	2.31E-06	1.47E-04	1.53E-05
CE143	9.89E-08	5.37E-08	7.77E-09	NO DATA	2.26E-08	3.12E-05	3.44E-05
CE144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	NO DATA	8.11E-07	1.17E-04	2.63E-05
[illegible]144	1.61E-11	4.99E-12	8.10E-13	NO DATA	2.64E-12	4.23E-07	5.32E-08
[illegible]147	2.92E-06	2.36E-06	1.84E-07	NO DATA	1.30E-06	8.87E-05	2.22E-05
[illegible]187	4.41E-09	2.61E-09	1.17E-09	NO DATA	NO DATA	1.11E-05	2.46E-05
NP239	1.26E-07	9.04E-09	6.35E-09	NO DATA	2.63E-08	1.57E-05	1.73E-05

TABLE 3-1b

INHALATION DOSE FACTORS FOR INFA

(MREM PER PCI INAHLED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	[illegible]
H 3	NO DATA	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.6[illegible]
C 14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-[illegible]
NA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.37E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-06
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.17E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.05E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91M	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05

This table was taken from
NRC Regulatory Guide 1.109
[illegible]le E-10

TABLE 3-1b CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.07E-07	NO DATA	2.91E-09	NO DATA	NO DATA	5.46E-05	1.19E-04
ZR 95	8.24E-05	1.99E-05	1.45E-05	NO DATA	2.22E-05	1.25E-03	1.55E-05
ZR 97	1.07E-07	1.83E-08	8.36E-09	NO DATA	1.85E-08	7.88E-05	1.00E-04
NB 95	1.12E-05	4.59E-06	2.70E-06	NO DATA	3.37E-06	3.42E-04	9.05E-06
MO 99	NO DATA	1.18E-07	2.31E-08	NO DATA	1.89E-07	9.63E-05	3.48E-05
TC 99M	9.98E-13	2.06E-12	2.66E-11	NO DATA	2.22E-11	5.79E-07	1.45E-06
TC101	4.65E-14	5.98E-14	5.80E-13	NO DATA	6.99E-13	4.17E-07	6.03E-07
RU103	1.44E-06	NO DATA	4.85E-07	NO DATA	3.03E-06	3.94E-04	1.15E-05
RU105	8.74E-10	NO DATA	2.93E-10	NO DATA	6.42E-10	1.12E-05	3.46E-05
RU106	6.20E-05	NO DATA	7.77E-06	NO DATA	7.61E-05	8.26E-03	1.17E-04
AG110M	7.13E-06	5.16E-06	3.57E-06	NO DATA	7.80E-06	2.62E-03	2.36E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	NO DATA	3.19E-04	9.22E-06
TE127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.47E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37F-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26F-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.73E-13	4.25E-06	3.64E-05

TABLE 3-1b CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	NO DATA	4.64E-14	2.12E-06	3.39E-06
BA142	2.84E-11	2.36E-14	1.40E-12	NO DATA	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	NO DATA	NO DATA	1.20E-04	6.06E-05
LA142	7.36E-10	2.69E-10	6.46E-11	NO DATA	NO DATA	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
CE143	2.09E-07	1.98E-07	1.58E-08	NO DATA	4.03E-08	8.30E-05	3.55E-05
CE144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	NO DATA	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	NO DATA	4.80E-12	1.15E-06	3.06E-06
ND147	5.67E-06	5.81E-06	3.57E-07	NO DATA	2.25E-06	2.30E-04	2.23E-05
W 187	9.26E-09	6.44E-09	2.23E-09	NO DATA	NO DATA	2.83E-05	2.54E-05
NP239	2.65E-07	2.37E-08	1.34E-08	NO DATA	4.73E-08	4.25E-05	1.78E-05

TABLE 3-2

GROUND PLANE DOSE FACTOR

(MREM/HR PER PCI/M^2)

LEMENT	TOTAL BODY	ELEMENT	TOTAL BODY
H-3	0.0	Ru-103	3.60E-09
C-14	0.0	Ru-105	4.50E-09
NA-24	2.50E-08	Ru-106	1.50E-09
P-32	0.0	Ag-110M	1.80E-08
Cr-51	2.20E-10	Te-125M	3.50E-11
Mn-54	5.80E-09	Te-127M	1.10E-12
Mn-56	1.10E-08	Te-127	1.00E-11
Fe-55	0.0	Te-129M	7.70E-10
Fe-59	8.00E-09	Te-129	7.10E-10
Co[illegible]	7.00E-09	Te-131M	8.40E-09
C[illegible]	1.70E-08	Te-131	2.20E-09
Ni-63	0.0	Te-132	1.70E-09
Ni-65	3.70E-09	I-130	1.40E-08
Cu-64	1.50E-09	I-131	2.80E-09
Zn-65	4.00E-09	I-132	1.70E-08
Zn-69	0.0	I-133	3.70E-09
Br-83	6.40E-11	I-134	1.60E-08
Br-84	1.20E-08	I-135	1.20E-08
Br-85	0.0	Cs-134	1.20E-08
Rb-86	6.30E-10	Cs-136	1.50E-08
Rb-88	3.50E-09	Cs-137	4.20E-09
Rb-89	1.50E-08	Cs-138	2.10E-08
Sr-89	5.60E-13	Ba-139	2.40E-09
Sr-91	7.10E-09	Ba-140	2.10E-09
Sr-92	9.00E-09	Ba-141	4.30E-09
Y-90	2.20E-12	Ba-142	7.90E-09
Y-91M	3.80E-09	La-140	1.50E-08
Y-91	2.40E-11	La-142	1.50E-08
Y-92	1.60E-09	Ce-141	5.50E-10
Y-93	5.70E-10	Ce-143	2.20E-09
Zr-95	5.00E-09	Ce-144	3.20E-10
Zr-97	5.50E-09	Pr-143	0.0
N[illegible]5	5.10E-09	Pr-144	2.00E-10
Mo[illegible]	1.90E-09	Nd-147	1.00E-09
Tc-[illegible]M	9.60E-10	W-187	3.10E-09
Tc-101	2.70E-09	Np-239	9.50E-10

TABLE 3-3a

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C 14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06F-06	5.06E-06
NA 24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P 32	1.70E-03	1.00E-04	6.59E-05	NO DATA	NO DATA	NO DATA	2.30E-05
CR 51	NO DATA	NO DATA	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN 54	NO DATA	1.99E-05	4.51E-06	NO DATA	4.41E-06	NO DATA	7.31E-06
MN 56	NO DATA	8.18E-07	1.41E-07	NO DATA	7.03E-07	NO DATA	7.43F-05
FE 55	1.39E-05	8.98E-06	2.40E-06	NO DATA	NO DATA	4.39E-06	1.14E-06
FE 59	3.08E-05	5.38E-05	2.12E-05	NO DATA	NO DATA	1.59E-05	2.57E-05
CO 58	NO DATA	3.60E-06	8.98E-06	NO DATA	NO DATA	NO DATA	8.97E-06
60	NO DATA	1.08E-05	2.55E-05	NO DATA	NO DATA	NO DATA	2.57E-05
63	6.34E-04	3.92E-05	2.20E-05	NO DATA	NO DATA	NO DATA	1.95E-06
NI 65	4.70E-06	5.32E-07	2.42E-07	NO DATA	NO DATA	NO DATA	4.05E-05
CU 64	NO DATA	6.09E-07	2.82E-07	NO DATA	1.03E-06	NO DATA	1.25E-05
ZN 65	1.84E-05	6.31E-05	2.91E-05	NO DATA	3.06E-05	NO DATA	5.33E-05
ZN 69	9.33E-08	1.68E-07	1.25E-08	NO DATA	6.98E-08	NO DATA	1.37F-05
BR 83	NO DATA	NO DATA	3.63E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	3.82E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.94E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.70E-04	8.40E-05	NO DATA	NO DATA	NO DATA	4.35E-06
RB 88	NO DATA	4.98E-07	2.73E-07	NO DATA	NO DATA	NO DATA	4.85F-07
RB 89	NO DATA	2.86E-07	1.97E-07	NO DATA	NO DATA	NO DATA	9.74E-08
SR 89	2.51E-03	NO DATA	7.20E-05	NO DATA	NO DATA	NO DATA	5.16E-05
SR 90	1.85E-02	NO DATA	4.71E-03	NO DATA	NO DATA	NO DATA	2.31E-04
SR 91	5.00E-05	NO DATA	1.81E-06	NO DATA	NO DATA	NO DATA	5.92E-05
SR 92	1.92E-05	NO DATA	7.13E-07	NO DATA	NO DATA	NO DATA	2.07E-04
Y 90	8.69E-08	NO DATA	2.33E-09	NO DATA	NO DATA	NO DATA	1.20E-04
Y 91M	8.10E-10	NO DATA	2.76E-11	NO DATA	NO DATA	NO DATA	2.70E-06
Y 91	1.13E-06	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	8.10E-05
Y 92	7.65E-09	NO DATA	2.15E-10	NO DATA	NO DATA	NO DATA	1.46E-04

is table was taken from
C Regulatory Guide 1.109
Table E-14

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	2.43E-08	NO DATA	6.62E-10	NO DATA	NO DATA	NO DATA	1.92E-04
ZR 95	2.06E-07	5.02E-08	3.56E-08	NO DATA	5.41E-08	NO DATA	2.50E-05
ZR 97	1.48E-08	2.54E-09	1.16E-09	NO DATA	2.56E-09	NO DATA	1.62E-04
NB 95	4.20E-08	1.73E-08	1.00E-08	NO DATA	1.24E-08	NO DATA	1.46E-05
MO 99	NO DATA	3.40E-05	6.63E-06	NO DATA	5.08E-05	NO DATA	1.12E-05
TC 99M	1.92E-09	3.96E-09	5.10E-08	NO DATA	4.26E-08	2.07E-09	1.15E-06
TC101	2.27E-09	2.86E-09	2.83E-08	NO DATA	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	NO DATA	4.95E-07	NO DATA	3.08E-06	NO DATA	1.80E-05
RU105	1.36E-07	NO DATA	4.58E-08	NO DATA	1.00E-06	NO DATA	5.41E-05
RU106	2.41E-05	NO DATA	3.01E-06	NO DATA	2.85E-05	NO DATA	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	NO DATA	1.04E-06	NO DATA	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	NO DATA	NO DATA	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	NO DATA	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	NO DATA	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	NO DATA	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	NO DATA	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	NO DATA	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	NO DATA	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	NO DATA	3.81E-05
I 130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	NO DATA	2.83E-06
I 131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	NO DATA	1.51E-06
I 132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	NO DATA	2.73E-06
I 133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	NO DATA	3.08E-06
I 134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	NO DATA	1.84E-06
I 135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	NO DATA	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	NO DATA	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	NO DATA	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	NO DATA	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	NO DATA	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	NO DATA	3.51E-10	3.54E-10	5.58E-05

TABLE 3-3a CONT'D

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	1.71E-04	1.71E-07	8.81E-06	NO DATA	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	NO DATA	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	NO DATA	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	NO DATA	NO DATA	NO DATA	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	NO DATA	NO DATA	NO DATA	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	NO DATA	1.48E-08	NO DATA	2.48E-05
CE143	1.48E-08	9.82E-06	1.17E-09	NO DATA	2.86E-09	NO DATA	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	NO DATA	4.93E-07	NO DATA	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	NO DATA	1.13E-08	NO DATA	4.29E-05
[illegible]44	2.74E-10	1.06E-10	1.38E-11	NO DATA	3.84E-11	NO DATA	4.93E-06
[illegible]47	5.53E-08	5.68E-08	3.48E-09	NO DATA	2.19E-08	NO DATA	3.60E-05
[illegible] 187	9.03E-07	6.28E-07	2.17E-07	NO DATA	NO DATA	NO DATA	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	NO DATA	1.98E-09	NO DATA	2.87E-05

TABLE 3-3b

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	2.03E-07	2.01E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C 14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA 24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P 32	8.25E-04	3.86E-05	3.18E-05	NO DATA	NO DATA	NO DATA	2.28E-05
CR 51	NO DATA	NO DATA	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN 54	NO DATA	1.07E-05	2.85E-06	NO DATA	3.00E-06	NO DATA	8.98E-06
MN 56	NO DATA	3.34E-07	7.54E-08	NO DATA	4.04E-07	NO DATA	4.84E-05
FE 55	1.15E-05	6.10E-06	1.89E-06	NO DATA	NO DATA	3.45E-06	1.13E-06
FE 59	1.65E-05	2.67E-05	1.33E-05	NO DATA	NO DATA	7.74E-06	2.78E-05
CO 58	NO DATA	1.80E-06	5.51E-06	NO DATA	NO DATA	NO DATA	1.05E-05
CO 60	NO DATA	5.29E-06	1.56E-05	NO DATA	NO DATA	NO DATA	2.93E-05
NI 63	5.38E-04	2.88E-05	1.83E-05	NO DATA	NO DATA	NO DATA	1.94E-06
NI 65	2.22E-06	2.09E-07	1.22E-07	NO DATA	NO DATA	NO DATA	2.56E-05
CU 64	NO DATA	2.45E-07	1.48E-07	NO DATA	5.92E-07	NO DATA	1.15E-05
ZN 65	1.37E-05	3.65E-05	2.27E-05	NO DATA	2.30E-05	NO DATA	6.41E-06
ZN 69	4.38E-08	6.33E-08	5.85E-09	NO DATA	3.84E-08	NO DATA	3.99E-06
BR 83	NO DATA	NO DATA	1.71E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.98E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	9.12E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	6.70E-05	4.12E-05	NO DATA	NO DATA	NO DATA	4.31E-06
RB 88	NO DATA	1.90E-07	1.32E-07	NO DATA	NO DATA	NO DATA	9.32E-09
RB 89	NO DATA	1.17E-07	1.04E-07	NO DATA	NO DATA	NO DATA	1.02E-09
SR 89	1.32E-03	NO DATA	3.77E-05	NO DATA	NO DATA	NO DATA	5.11E-05
SR 90	1.70E-02	NO DATA	4.31E-03	NO DATA	NO DATA	NO DATA	2.29E-04
SR 91	2.40E-05	NO DATA	9.06E-07	NO DATA	NO DATA	NO DATA	5.30E-05
SR 92	9.03E-06	NO DATA	3.62E-07	NO DATA	NO DATA	NO DATA	1.71E-04
Y 90	4.11E-08	NO DATA	1.10E-09	NO DATA	NO DATA	NO DATA	1.17E-04
Y 91M	3.82E-10	NO DATA	1.39E-11	NO DATA	NO DATA	NO DATA	7.48E-07
Y 91	6.02E-07	NO DATA	1.61E-08	NO DATA	NO DATA	NO DATA	8.02E-05
Y 92	3.60E-09	NO DATA	1.03E-10	NO DATA	NO DATA	NO DATA	1.04E-04

This table was taken from
NRC Regulatory Guide 1.109
Table E-13

TABLE 3-3b CONT'D

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
ZR 95	1.16E-07	2.55E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
ZR 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
NB 95	2.25E-08	8.76E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
MO 99	NO DATA	1.33E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
TC 99M	9.23E-10	1.81E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06
TC101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
RU105	6.45E-08	NO DATA	2.34E-08	NO DATA	5.67E-07	NO DATA	4.21E-05
RU106	1.17E-05	NO DATA	1.46E-06	NO DATA	1.58E-05	NO DATA	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	NO DATA	6.78E-07	NO DATA	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	NO DATA	NO DATA	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	NO DATA	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	NO DATA	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	NO DATA	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	NO DATA	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	NO DATA	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	NO DATA	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	NO DATA	4.50E-05
I 130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	NO DATA	2.76E-06
I 131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	NO DATA	1.54E-06
I 132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	NO DATA	1.73E-06
I 133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	NO DATA	2.95E-06
I 134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	NO DATA	5.16E-07
I 135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	NO DATA	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	NO DATA	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	NO DATA	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	NO DATA	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	NO DATA	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	NO DATA	1.93E-10	1.30E-10	2.39E-05

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	NO DATA	NO DATA	NO DATA	9.84E-05
LA142	5.24E-10	1.67E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
CE141	3.97E-08	1.98E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
[illegible]187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

TABLE 3-4

TOTAL BODY DOSE FACTORS

Ki

FROM NOBLE GASES (GAMMA)

NUCLIDE	GAMMA*		1.0E+6(pCi/μCi)		FINITE CLOUD ** CORRECTION FACTOR	Ki***
Kr-83m	7.56E-8	X	1.0E+6	X	0.77	5.82E-2
Kr-85m	1.17E-3	X	1.0E+6	X	0.63	7.37E+2
Kr-85	1.61E-5	X	1.0E+6	X	0.54	8.71E+0
Kr-87	5.92E-3	X	1.0E+6	X	0.43	2.55E+3
Kr-88	1.47E-2	X	1.0E+6	X	0.40	5.89E+3
Kr-89	1.66E-2	X	1.0E+6	X	0.42	7.02E+3
Kr-90	1.56E-2	X	1.0E+6	X	0.46	7.18E+3
Xe-131m	9.15E-5	X	1.0E+6	X	0.76	6.92E+1
Xe-133m	2.51E-4	X	1.0E+6	X	0.72	1.80E+2
Xe-133	2.94E-4	X	1.0E+6	X	0.77	2.26E+2
Xe-135m	3.12E-3	X	1.0E+6	X	0.54	1.70E+3
Xe-135	1.81E-3	X	1.0E+6	X	0.64	1.17E+3
Xe-137	1.42E-3	X	1.0E+6	X	0.51	7.27E+2
Xe-138	8.83E-3	X	1.0E+6	X	0.44	3.87E+3
Ar-41	8.84E-3	X	1.0E+6	X	0.45	3.98E+3

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6.

*** Ki (mrem/yr per μCi/m^3)

TABLE 3-5

SKIN DOSE FACTORS

Li

FROM NOBLE GASES (BETA)

NUCLIDE	B - SKIN		1.0E+6(pCi/μCi)	Li **
Kr-83m		X	1.0E+6	
Kr-85m	1.46E-3	X	1.0E+6	1.46E+3
Kr-85	1.34E-3	X	1.0E+6	1.34E+3
Kr-87	9.73E-3	X	1.0E+6	9.73E+3
Kr-88	2.37E-3	X	1.0E+6	2.37E+3
Kr-89	1.01E-2	X	1.0E+6	1.01E+4
Kr-90	7.29E-3	X	1.0E+6	7.29E+3
Xe-131m	4.76E-4	X	1.0E+6	4.76E+2
Xe-133m	9.94E-4	X	1.0E+6	9.94E+2
Xe-133	3.06E-4	X	1.0E+6	3.06E+2
Xe-135m	7.11E-4	X	1.0E+6	7.11E+2
Xe-135	1.86E-3	X	1.0E+6	1.86E+3
Xe-137	1.22E-2	X	1.0E+6	1.22E+4
Xe-138	4.13E-3	X	1.0E+6	4.13E+3
Ar-141	2.69E-3	X	1.0E+6	2.69E+3

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** Li (mrem/yr per μCi/m^3)

TABLE 3-6

AIR DOSE FACTORS

Mi

FROM NOBLE GASES (GAMMA)

NUCLIDE	GAMMA *		1.0E+6(pCi/μCi)		FINITE CLOUD ** CORRECTION FACTOR	Mi ***
Kr-83m	1.93E-5	X	1.0E+6	X	0.77	1.49E+1
Kr-85m	1.23E-3	X	1.0E+6	X	0.63	7.75E+2
Kr-85	1.72E-5	X	1.0E+6	X	0.54	9.31E+0
Kr-87	6.17E-3	X	1.0E+6	X	0.43	2.66E+3
Kr-88	1.52E-2	X	1.0E+6	X	0.40	6.10E+3
Kr-89	1.73E-2	X	1.0E+6	X	0.42	7.32E+3
Kr-90	1.63E-2	X	1.0E+6	X	0.46	7.50E+3
Xe-131m	1.56E-4	X	1.0E+6	X	0.76	1.17E+2
Xe-133m	3.27E-4	X	1.0E+6	X	0.72	2.34E+2
Xe-133	3.53E-4	X	1.0E+6	X	0.77	2.71E+2
Xe-135m	3.36E-3	X	1.0E+6	X	0.54	1.83E+3
Xe-135	1.92E-3	X	1.0E+6	X	0.64	1.24E+3
Xe-137	1.51E-3	X	1.0E+6	X	0.51	7.73E+2
Xe-138	9.21E-3	X	1.0E+6	X	0.44	4.03E+3
Ar-41	9.30E-3	X	1.0E+6	X	0.45	4.19E+3

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6

*** Mi (mrad/yr per μCi/m^3)

TABLE 3-7

AIR DOSE FACTORS (Ni) FROM NOBLE GASES (BETA)

NUCLIDE	*BETA AIR	1.0E+6(pCi/μCi)	Ni**
Kr-83m	2.88E-04	1.0E+6	2.88E+02
Kr-85m	1.97E-03	1.0E+6	1.97E+03
Kr-85	1.95E-03	1.0E+6	1.95E+03
Kr-87	1.03E-02	1.0E+6	1.03E+04
Kr-88	2.93E-03	1.0E+6	2.93E+03
Kr-89	1.06E-02	1.0E+6	1.06E+04
Kr-90	7.83E-03	1.0E+6	7.83E+03
Xe-131m	1.11E-03	1.0E+6	1.11E+03
Xe-133m	1.48E-03	1.0E+6	1.48E+03
Xe-133	1.05E-03	1.0E+6	1.05E+03
Xe-135m	7.39E-04	1.0E+6	7.39E+02
Xe-135	2.46E-03	1.0E+6	2.46E+03
Xe-137	1.27E-02	1.0E+6	1.27E+04
Xe-138	4.75E-03	1.0E+6	4.75E+03
Ar-41	3.28D-03	1.0E+6	3.28E+03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** Ni (mrad/yr per μCi/m^3)

TABLE 3-8

DOSE FACTORS FOR SITE BOUNDARY USING STANDARD ISOTOPIC MIXTURES

INSTANTANEOUS RELEASE MIXTURE

NUCLIDE	RELATIVE ABUNDANCE
Kr 85m	5.56E-2
Kr 87	5.70E-2
Kr 88	11.95E-2
Xe 133m	1.14E-2
Xe 133	53.57E-2
Xe 135m	12.01E-2
Xe 135	3.25E-2
Ar 41	6.82E-2

WEIGHTED DOSE FACTORS

$\overline{K}$ = 1.53E+3 (mrem - m^3 per μCi-yr)

$\overline{L}$ = 1.42E+3 (mrem - m^3 per μCi-yr)

$\overline{M}$ = 1.62E+3 (mrad - m^3 per μCi-yr)

$\overline{N}$ = 2.02E+3 (mrad - m^3 per μCi-yr)

TIME AVERAGED RELEASE MIXTURE

NUCLIDE	RELATIVE ABUNDANCE
Kr 85	5.33E-5
Kr 85m	1.63E-2
Xe 131m	4.72E-4
Xe 133	7.89E-1
Xe 133m	4.46E-4
Xe 135	1.93E-1

WEIGHTED DOSE FACTORS

$\overline{K}$ = 2.90E2 (mrem - m^3 per μCi-yr)

$\overline{L}$ = 6.25E2 (mrem - m^3 per μCi-yr)

$\overline{M}$ = 3.26E2 (mrad - m^3 per μCi-yr)

$\overline{N}$ = 1.34E3 (mrad - m^3 per μCi-yr)

TABLE 3-8 BASES

Instantaneous Mix:

These dose factors are generated from the mixture that would be seen in the reactor coolant (undecayed) if the unit were operated with several leaking rods with exposed fuel. The mixture was chosen based upon review of pressurized reactor coolant samples taken during operation with varying fuel conditions (pct, exposed fuel, tramp only). This mixture provided the most restrictive mixture and is used to calculate a conservative instantaneous release rate in μCi/sec before an actual sample of the release is available (see Appendix 3A).

Time Averaged Release Mixture:

This mixture is the conservative time averaged release mixture taken from a review of three years of semi-annual effluent reports. This mixture was from the most restrictive release period (first quarter 1984) reviewed. These dose factors are used to determine representative time averaged release rates in curies/seconds.

TABLE 3-9

LOCATIONS OF SITE BOUNDARY AND NEAREST RESIDENCE

SECTOR	DISTANCE * NEAREST POINT OF SITE BOUNDARY (Meters)	DISTANCE * NEAREST RESIDENCE
N	RIVER	1950
NNW	RIVER	1740
NW	RIVER	1830
WNW	RIVER	1830
W	RIVER	1890
WSW	RIVER	2135
SW	350	2745
SSW	380	1525
S	580	1280
SSE	595	1220
SE	580	1100
ESE	580	1070
E	625	730
ENE	760	1370
NE	790	1525
NNE	RIVER	3050

* Measured from Indian Point No. 3.

APPENDIX 3-A

CALCULATION OF ALLOWABLE RELEASE RATES

Primary Assumptions:

1. Unit 3 and Unit 2 effective dose factor Keff, values are equivalent.

2. Each unit shares 50% of the total allowable release rate, Q, in Ci s-1. Therefore, Q3 = Q2 for instantaneous releases.

Given:

	LOCATION	UNIT 3	UNIT 2	LOCATION
Noble Gas X/Q	(SSW 380m)	4.85E-6 s/m^3	2.54E-6	(SSW 579m)
Wv(in) Annual Average Site Boundary X/Q	(SW 350m)	5.21E-6 s/m^3	2.54E-6	(SSW 579m)
Wv(gp) Annual Average Ground Plane Site Boundary Deposition	(SSW 380m)	2.72E-8 $1/m^2$		
Wv(f) Food Pathway Dispersion Parameter	(SSW 5mi)	1.35E-9 $1/m^2$		
Wv(in) Annual Average X/Q (5 mi)	(SSW 5mi)	7.22E-7 sec/m^3		
Wv(in) Inhalation Pathway Nearest Residence	(SSW 1526m)	8.96E-7 sec/m^3		
Wv(gp) Annual Average Ground Plane Deposition Parameter Nearest Residence	(S 1379m)	6.14E-9 $1/m^2$		

6

INSTANTANEOUS RELEASE RATE VS. DOSE RATE UNITS 2 & 3

Indian Point 3 and 2 share a common site boundary limit of 500 mrem/yr. This 500 mrem/yr limit is divided between units 3 and 2 based upon a 50-50 split of the release rate in μCi/sec. Because each unit has its own X/Q and K eff, equal μCi/sec discharges from each plant will result in different dose rates for each plant at the most restrictive site boundary location. In order to define the split of the 500 mrem/yr limit, units 3 and 2 have agreed to base the dose split on the mixture presented in Table 3A-1.

Dose Split Between IP2 and IP3

A. Instantaneous Dose Rate: Calculation of Allowable Release Rate: Noble Gas Release Including Finite Cloud Correction for Site Boundary.

i. Whole Body

Given:

a) site limit is 500 mrem/yr
b) IP3 X/Q for SSW sector = 4.85E-6 sec/m^3
c) K eff for IP3 SSW sector = 1.58E+3 $\frac{\text{mrem - m}^3}{\mu\text{Ci - yr}}$
d) IP2 X/Q for SSW sector = 2.54E-6 sec/m^3
e) IP2 K eff for SSW sector = 2.43E+3 $\frac{\text{mrem - m}^3}{\mu\text{Ci - yr}}$
f) Q = μCi/sec

Solve for Q:

$$Q[(X/Q_3)\ (K\ eff_3) + (X/Q_2)\ (K\ eff_2)] = 500 \text{ mrem/yr}$$

$$Q[(4.85E-6)\ (1.58E+3) + (2.54E-6)\ (2.43E+3)] = 500 \text{ mrem/yr}$$

$$Q = 3.61E+4\ \mu\text{Ci/sec}$$

ii. Skin

Given:

a) site limit is 3,000 mrem/yr
b) IP3 X/Q for SSW sector = 4.85E-6 sec/m^3
c) IP3 (Li + 1.1 Mi) = 3.35E+3 $\frac{\text{mrem - m}^3}{\mu\text{Ci - yr}}$
d) IP2 X/Q for SSW sector = 2.54E-6 sec/m^3
e) IP2 (Li + 1.1 Mi) = 4.38E+3 $\frac{\text{mrem - m}^3}{\mu\text{Ci - yr}}$
f) Q = μCi/sec

Solve for Q:

$Q[(X/Q3)\ (Li + 1.1\ Mi_3) + (X/Q)\ (Li + 1.1\ Mi_2)] = 3{,}000$ mrem/yr

$Q[(4.85E-6)\ (3.35E+3) + (2.54E-6)\ (4.38E+3)] = 3{,}000$ mrem/yr

$Q = 1.09E+5$ μCi/sec

Solve for dose commitments per site with Q = 3.61E+4 μCi/sec (whole body dose and the most restrictive rate).

IP3:

$(3.61E+4\ \mu Ci/sec)\ (4.85E-6\ sec/m^3)\ (1.58E+3\ \frac{mrem - m^3}{\mu Ci - yr}) = 277$ mrem/yr

IP2:

$(3.61E+4\ \mu Ci/sec)\ (2.54E-6\ sec/m^3)\ (2.43E+3\ \frac{mrem - m^3}{\mu Ci - yr}) = 223$ mrem/yr

Unit 3 has 55.4% and Unit 2 has 44.6% of the 500 mrem/yr instantaneous release rate limit.

B. The conservative instantaneous release rate calculated in above step A.1 is based upon the mixture presented in Table 3A-1 solely for the purpose of splitting the dose rate as shown above. To determine an administrative release rate for IP3 based on the 277 mrem/yr dose rate (i.e., no sharing), the mix in Table 3-8 is used. The 277 mrem/yr limit and the mixture presented in Table 3-8 are used to calculate a μCi/sec instantaneous limit for IP3.

Given:

a) IP3 site boundary limit is 277 mrem/yr
b) IP3 X/Q ssw sector = $4.85E-6\ sec/m^3$
c) IP3 K eff (Table 3-8) = $1.53E+3\ \frac{mrem - m^3}{\mu Ci - yr}$
d) Q = μCi/sec

Solve for Q:

$Q(4.85E-6)\ (1.53E+3) = 277$ mrem/yr
$Q = 3.73E+4$ μCi/sec

Table 3A-1

MIXTURE FOR SHARED LIMITS

Isotope	Abundance
Kr-85m	.0362
Kr-88	.0790
Xe-133	.4027
Xe-135m	.0740
Xe-138	.1467
Xe-135	.2614

	IP3	IP2
Ki*	1.58E+3	2.43E+3
Li	1.51E+3	1.51E+3
Mi*	1.67E+3	2.61E+3

Ki units $\frac{mrem - m^3}{\mu Ci - yr}$

Li units $\frac{mrem - m^3}{\mu Ci - yr}$

Mi units $\frac{mrad - m^3}{mrem - yr}$

The SSW sector is the most restrictive for both whole body exposure and skin exposure for both units 2 and 3.

* Dose factors Ki and Mi are finite cloud corrected for each reactor unit and hence they are not identical.

RELEASE RATE LIMITS

QUARTERLY AND ANNUAL AVERAGE NOBLE GAS RELEASES

For a Calendar Quarter	For A Calendar Year
gamma air dose 5 mrad limit	gamma air dose 10 mrad limit
beta air dose 10 mrad limit	beta air dose 20 mrad limit

I. Assumptions:

1. Doses are delivered to the air at the site boundary.
2. Finite cloud geometry is assumed for noble gas releases at site boundary.
3. X/Q for Unit 3 = 4.85E-6 s/m^3, (Q = release rate μCi/s)
4. Gamma air dose factor (M), Corrected for finite cloud geometry is: $M = 3.26E{+}2 \frac{mrad - m^3}{\mu Ci - yr}$ (time average mix from Table 3-8)
5. Beta air dose factor (N) is unaffected by finite cloud assumption: $N = 1.3E{+}3 \frac{mrad - m^3}{\mu Ci - yr}$

II. Calculation of Quarterly Release Rates:

a) for gamma dose: (Q)x[(M)(X/Q)] less than or equal to 5 mrad/qtr (20 mrad/yr)
b) for beta dose: (Q)x[(N)(X/Q)] less than or equal to 10 mrad/qtr (40 mrad/yr)

Solve for a. $Q = \frac{5\ mrad/qtr}{(M)\ (X/Q)}$ = 1.26E+4 μCi/s = 1.26E-2 Ci/s

Solve for b. $Q = \frac{10\ mrad/qtr}{(N)\ (X/Q)}$ = 6.34E+3 μCi/s = 6.34E-3 Ci/s

Based on the above analysis the beta dose is limiting for time average doses and therefore the allowable quarterly average release rate is 1.01E-3 Ci/s.

III. Calculation of - Calendar Year: Release Rate

Annual limits are 1/2 the quarterly limits therefore maximum allowable annual average release rate is 3.17E+3 μCi/s or 3.17E-3 Ci/s.

NOTE: M and N values are taken from Table 3-8 for time average release mixture.

ALLOWABLE INSTANTANEOUS RELEASE RATE
IODINE 131/PARTICULATES ($T_{½}$ GREATER THAN 8 DAYS)

Given: $W_v(in)$: X/Q for IP3 = 5.21E-6 sec/m^3 @ 350m SW
$W_v(in)$: X/Q for IP2 = 2.54E-6 sec/m^3 @ 579m SSW

$$PI(c) = 1.62\text{ E7 } \frac{mrem/yr}{\mu Ci/m^3}$$

Assumed Pathway: Child Inhalation at Unrestricted Area Boundary

Solve the following equation for Q:

$$[(Q)PI(c)(W_v(in))\text{ Unit 3}] + [(Q)PI(c)(W_v(in))\text{ Unit 2}] = 1500\text{ mrem/yr}$$

IP3: $(Q)PI(c)(W_v(in))_3 = Q\ 1.62E7\ \frac{mrem/yr}{\mu Ci/m}\ 5.21E\text{-}6\ s/m^3 = Q\ 84.4\ \frac{mrem/yr}{\mu Ci/s}$

IP2: $(Q)PI(c)(W_v(in))_2 = Q\ 1.62E7\ \frac{mrem/yr}{\mu Ci/m}\ 2.54E\text{-}6\ s/m^3 = Q\ 41.1\ \frac{mrem/yr}{\mu Ci/s}$

The sum equals (125.5)(Q) mrem/yr per μCi/s.

Limit is 1500 mrem/yr per <u>site</u>:

Therefore: $125.5\ Q\ \frac{mrem/yr}{\mu Ci/s} = 1500\text{ mrem/yr}$

$Q = 1.20E{+}1\ \mu Ci/s$
$Q = 1.20E\text{-}5$ Ci/s per unit

IP3 Dose Contribution: $1.20E{+}1\ \frac{\mu Ci}{s} \times 1.62E7\ \frac{mrem}{yr}\ \frac{m^3}{\mu Ci} \times 5.21E\text{-}6\ \frac{s}{m^3} = 1{,}008$ mrem/yr

IP2 Dose Contribution: $1.20E{+}1\ \frac{\mu Ci}{s} \times 1.62E7\ \frac{mrem}{yr}\ \frac{m^3}{\mu Ci} \times 2.54E\text{-}6\ \frac{s}{m^3} = 492$ mrem/yr

Sum = 1500 mrem/yr

Approximately a 67.2%/32.8% dose split for IP3 and IP2 respectively.

ALLOWABLE RELEASE RATES FOR IODINE/PARTICULATE
TIME AVERAGE DOSES QUARTERLY AND ANNUAL DOSE LIMITS

There are two receptor pathways considered: a primary receptor - child at the nearest residence, and a secondary receptor - infant at 5 miles.

As discussed in the ODCM, both receptors will be considered when evaluating time averaged dose commitments. For the purpose of setting an administrative limit on quarterly and time average release rates, the secondary receptor was chosen because it proved more limiting (only long term releases were considered, e.g. the possibility of intermittent releases was not considered for the calculation).

Calculations for both receptor locations are included in this attachment for reference.

IODINE TIME AVERAGE*
(Primary Receptor)

Child at the nearest residence:

Given:** X/Q = 8.96E-7 s/m^3 at 1526m SSW inhalation
D/Q = 6.14E-9 1/m^2 at 1279m S ground plane deposition factor

RI(c) = 1.62E+7 $\frac{mrem/yr}{\mu Ci/m^3}$, child inhal. dose factor for I-131

RG = 2.1E+7 m^2 $\frac{mrem/yr}{\mu Ci/s}$

RV(c) = 4.77E+10 m^2 $\frac{mrem/yr}{\mu Ci/sec}$ vegetation path for child

Calculate the allowable time average release rate by solving the following equation for Q:

Q[(RIc)(X/Q) + (RG)(D/Q) + (RVc)(D/Q)] = limit in mrem/yr

(Q)(RIc)(X/Q) = 14.5 Q mrem/yr per μCi/s

(Q)(RG) (D/Q) = 0.1 Q mrem/yr per μCi/s

(Q)(RVc)(D/Q) = 293 Q mrem/yr per μCi/s

The sum equals 308 Q mrem/yr per μCi/s.

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr).

Solving for Q yields: Q 308 $\frac{mrem/yr}{\mu Ci/s}$ = 30 mrem/yr

Q = 9.74E-2 μCi/s
= 9.74E-8 Ci/s

Annual limit is ½ quarterly limit: 15 mrem to any organ (15 mrem/yr).

$$Q = \frac{9.74E\text{-}8}{2} = 4.87E\text{-}8 \text{ Ci/s}$$

* Iodine 131 and particulates with half-lives greater than 8 days are assumed to be I-131 for the purposes of this calculation which is a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates.

** Because the H-3 dose factor is about 4 orders of magnitude less than the Iodine dose factor, its contribution to the total dose is considered negligible.

IODINE TIME AVERAGE*
(Secondary Receptor)

Infant at 5 miles:

Given:** X/Q = 7.22E-7 s/m^3 downwind at 5 mi.
D/Q = 1.35E-9 1/m^2 downwind at 5 mi.

RI(i) = 1.48E7 mrem/yr per μCi/m^3, infant inhal. dose factor

RG = 2.1E7 m^2 mrem/yr per μCi/s, ground plane dose factor

RC(i) = 1.06E12 m^2 mrem/yr per μCi/s, cow-milk pathway dose factor for infant

RV(i): The infant vegetation factor is not calculated because the infant is assumed to have no intake of fresh vegetables.

Calculate the allowable time average release rate by solving the following equation for Q:

Q[(RIi)(X/Q) + (RG)(D/Q) + (RCi)(D/Q)] = limit in mrem/yr

Q(RIi)(X/Q) = 10.7 mrem/yr per μCi/s

Q(RG)(D/Q) = 0.03 mrem/yr per μCi/s

Q(RCi)(D/Q) = 1431 mrem/yr per μCi/s

The sum yields 1442 Q mrem/yr per μCi/s.

Quarterly time average limit is 7.5 mrem to any organ (or 30 mrem/yr).

Solving for Q yields: Q 1442 mrem/yr per μCi/s = 30 mrem/yr

Q = 2.08E-2 μCi/s
= 2.08E-8 Ci/s

Annual limit is ½ quarterly limit: 15 mrem to an organ (or 15 mrem/yr).

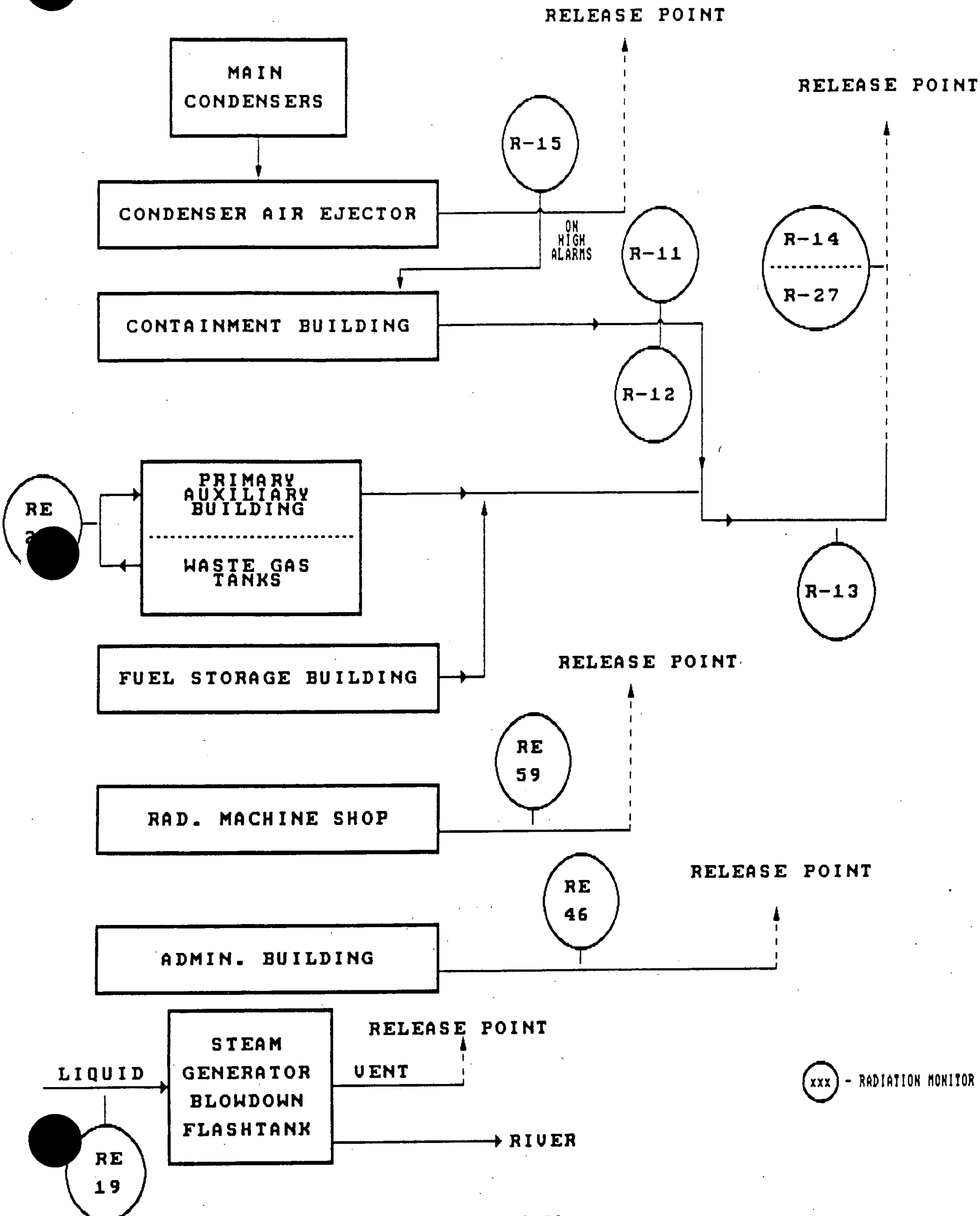
Q = 1.04E-8 Ci/s

* See note under Primary Receptor Calculation.
** See note under Primary Receptor Calculation.

GASEOUS RADIOACTIVE WASTE EFFLUENT SYSTEM

FLOW DIAGRAM

FIGURE 3.1



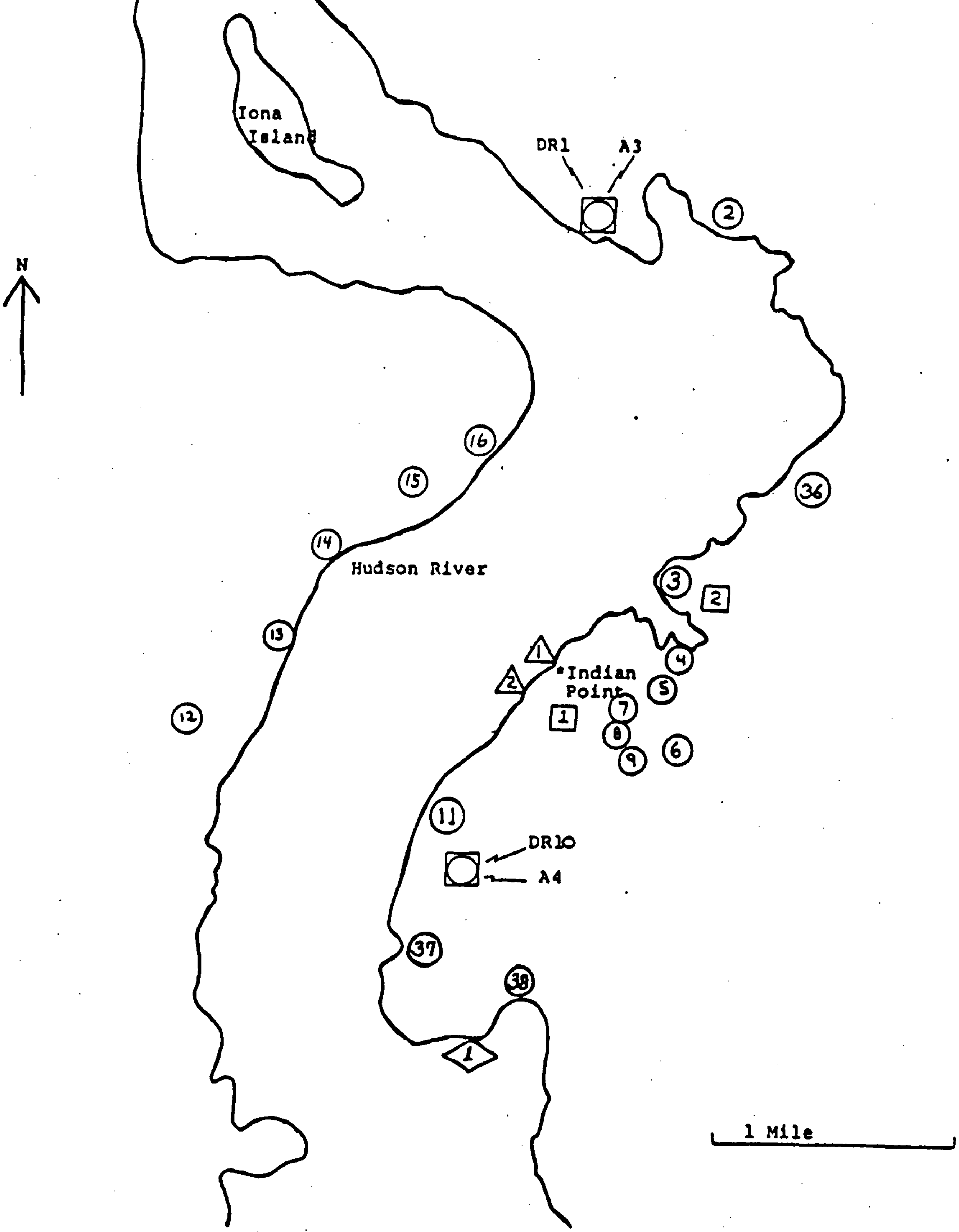
4.0 SAMPLE LOCATIONS

Figure 4.1 is a map which shows the location of environmental sampling points within 2.5 miles of the Indian Point Plant and Figure 4.2 is a map providing the same information for points at greater distances from the plant. Table 4.1 provides a description of environmental sample locations and the sample types collected at each of these locations.

The locations listed in Table 4.1 are the RETS designated locations only. The air sample locations were chosen considering the highest average annual D/Q sectors and the practicality of locating continuous air samplers. There are backup sample locations not listed in Table 4.1 that may be maintained to provide the program with additional supporting information.

RADIOLOGICAL ENVIRONMENTAL MONITORING - SAMPLING STATIONS

FIGURE 4-1



KEY:

△ - Waterborne Surface Wa#

○ - Direct Radiation Sample Location DR#

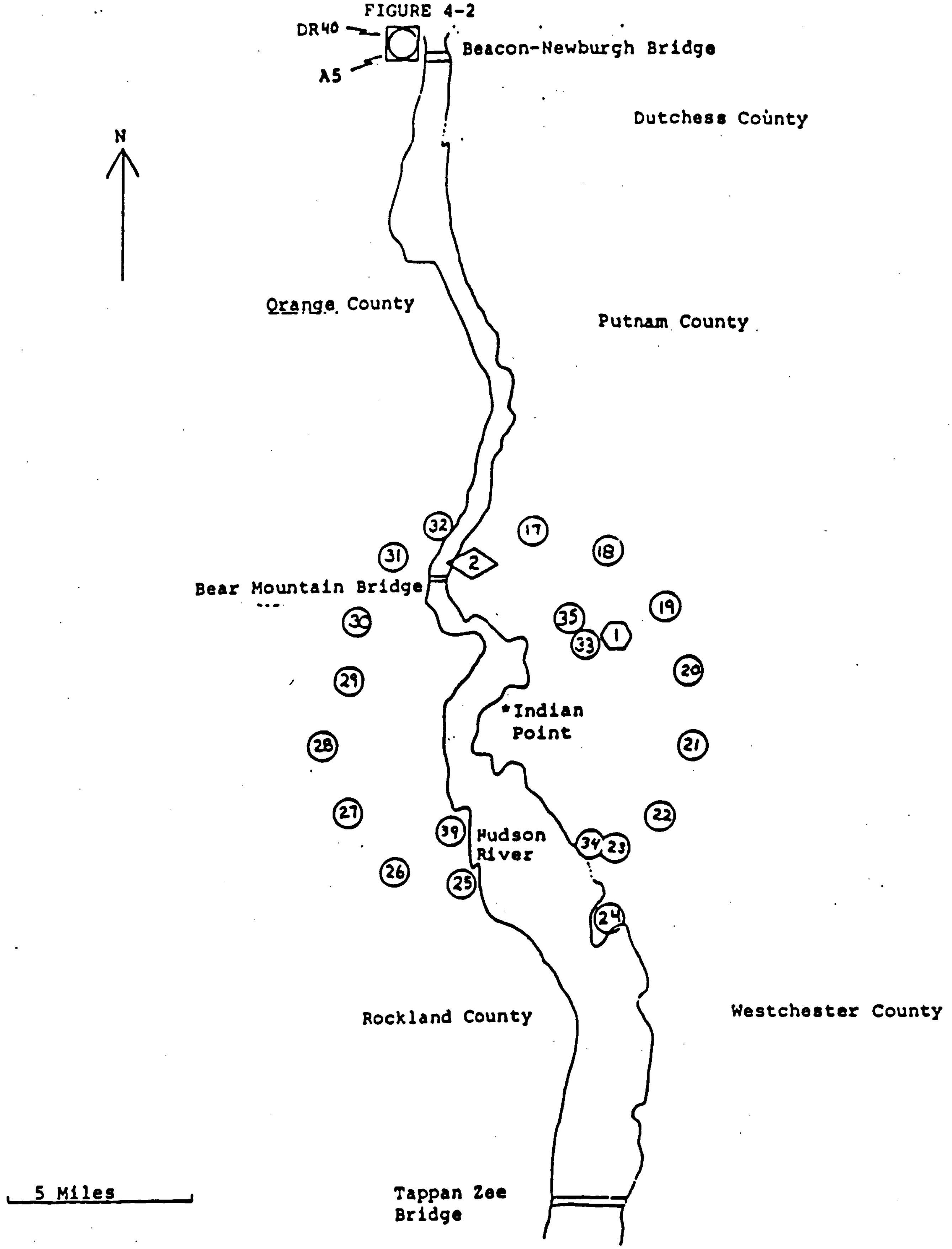
□ - Airborne Sample Location A#

⊡ - Direct Radiation/Airborne

◇ - Shoreline Sediment Wc#

RADIOLOGICAL ENVIRONMENTAL MONITORING - SAMPLING STATIONS

FIGURE 4-2



KEY:

- Direct Radiation Sample Location DR#
- Direct Radiation/Airborne
- Shoreline Sediment Wc#
- Waterborne, Drinking, WB#

TABLE 4.1
INDIAN POINT STATION
ENVIRONMENTAL SAMPLING STATION POINTS

RETS SAMPLE DESIGNATION	LOCATION	DISTANCE
Exposure Pathway/Sample: Direct Radiation		
DR1	Cortlandt Sanitation Garage	2 mi - N
DR2	Old Pemart Ave	1.8 mi - NNE
DR3	Charles Point	0.8 mi - NE
DR4	Lents Cove	0.5 mi - ENE
DR5	Broadway and Bleakley	0.4 mi - E
DR6	Sector Six Reuter Stokes Pole	0.5 mi - ESE
DR7	Water Meter House	0.3 mi - SE
DR8	Service Center Building	0.4 mi - SSE
DR9	SE Corner	0.6 mi - S
DR10	NYU Tower	0.8 mi - SSW
DR11	White Beach	0.9 mi - SW
DR12	Gays Hill Road South	1.5 mi - WSW
DR13	Gays Hill Road North	1 mi - W
DR14	Rt. 9W across from R/S #14	1.2 mi - WNW
DR15	Rt. 9W. South of Ayers Road	1 mi - NW
DR16	Ayers Road	0.9 mi - NNW
DR17	Rt. 9D Garrison	5 mi - N
DR18	Gallows Hill Road	5 mi - NNE
DR19	Westbrook Drive	5 mi - NE
DR20	Lincoln Road - Cortlandt	4.8 mi - ENE
DR21	Croton Ave. - Cortlandt	5 mi - E
DR22	Colabaugh Pond Rd. Cortlandt	5 mi - ESE
DR23	Mt. Airy & Windsor Road	5 mi - SE
DR24	Croton Point	6.4 mi - SSE
DR25	Warren Ave. Haverstraw	4.8 mi - S
DR26	Railroad Ave. & 9W Haverstraw	4.6 mi - SSW
DR27	Willow Grove Road & Birch Dr.	5 mi - SW
DR28	Palisades Parkway-Lake Welch	4.7 mi - NW
DR29	Palisades Parkway	4 mi - W
DR30	Anthony Wayne Park	4.5 mi - WNW
DR31	Palisades Pkwy South Exit	4.7 mi - NW
DR32	Rt. 9W Fort Montgomery	4.8 mi - NNW
DR33	Hamilton Street	3 mi - NE
DR34	Furnace Dock	3.5 mi - SE
DR35	Highland Ave. & Sprout Brook Rd. (near rock cut)	3 mi - NNE
DR36	Lower South Street	1.3 mi - NE
DR37	Verplank-Broadway & Sixth Str	1.3 mi - SSW
DR38	Montrose Marina	1.6 mi - S
DR39	Grassy Point	3.3 mi - SSW
DR40	*Roseton	20 mi - N

* Control Station

TABLE 4.1
(Continued)

RETS SAMPLE DESIGNATION	LOCATION	DISTANCE
Exposure Pathway/Sample: Airborne		
A1	Algonquin Gas Line	0.25 mi - SW
A2	Burnwell Gas Co.	0.8 mi - ENE
A3	Cortlandt Sanit. Garage	2 mi - N
A4	NYU Tower	0.8 mi - SSW
A5	*Roseton	20 mi - N
Exposure Pathway/Sample: Waterborne - Surface (Hudson River Water)		
Wa1	Plant Inlet	N/A
Wa2	Discharge Canal	N/A
Exposure Pathway/Sample: Waterborne - Drinking		
Wb1	Camp Field Reservoir	3.5 mi - NE
Exposure Pathway/Sample: Sediment from Shoreline		
Wc1	White Beach	0.9 mi - SW
Wc2	*Manitou Inlet	4.5 mi - NNW

* Control Station Location

Exposure Pathway/Sample: Milk

There are no milk animals within 8 km distance of Indian Point; therefore, no milk samples are taken.

Exposure Pathway/Sample: Ingestion-Fish and Invertebrates

The RETS designate two required sample locations labeled Ib1 and Ib2. The downstream Ib1 location and samples will be chosen where it is likely to be effected by plant discharge. Ib2 will be a location upstream that is not likely to be effected by plant discharge. The following fish species are considered acceptable sample species.

Striped Bass	Bluegill Sunfish
White Perch	Pumpkin Seed Sunfish
White Catfish	Blueback Herring
American Eel	Crabs

Exposure Pathway/Sample: Ingestion-Food Products (Broad Leaf Vegetation) (See Note 1)

Ic1	SW and SSW Sectors NYU	0 - 1 mile
Ic2	N & NE Sectors Campsmith	1 - 3 miles
Ic3	Roseton (North)	20 miles

TABLE 4.1

NOTES

NOTE 1

Radiochemical separation and analysis is not required for I-131 vegetation samples: as long as the required RETS LLD is met using gamma spectroscopy.

NOTE 2

The requirement to obtain and analyze samples from mulch animals within 8 km of the site is intended to ensure monitoring of the "cow-milk" and vegetation pathways. Such samples would only be of value were the milk used for human consumption. Thus, only mulch animals whose milk is used for human consumption are considered in the pathway and sample evaluation.

APPENDIX B

DETECTION CAPABILITIES

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

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

$$LLD = \frac{[2.71/Ts + 3.29sb(1+Tb/Ts)0.5]}{[E \times V \times k \times Y \times \exp(-rt)]}$$

Where:

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

T_s is the sample counting time in minutes.

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute).

T_b is the background count time in minutes.

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

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

k is a constant for the number of transformations per minute per unit of activity.

Y is the fractional radiochemical yield (when applicable).

r is the radioactive decay constant for the particular radionuclide.

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

Note: The above LLD formula accounts for differing background and sample count times. The IP3 Radiological Environmental Monitoring Program, REMP, uses an LLD formula that assumes equal background and sample count times, in accordance with Technical Specifications. When the above LLD formula is more appropriate for the effluents program, it may be used.

The value of s_b used in the caculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples. Typical values of E, V, Y, and t shall be used in the calculation. The background count rate is calculated from the background counts that are determined to be within ± one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma ray peak used for the quantitative analysis for that radionuclide.

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

To handle the a posteriori problem, a decision level must be defined. The remainder of Appendix B discusses the use of the Critical Level concept. Following an experimental observation, one must decide whether or not a real signal was, in fact, detected. This type of binary qualitative decision is subject to two kinds of error: deciding that the radioactive material is present when it is not (a: Type I error), and the converse, failing to decide that it is present when it is (b: Type II error). The maximum acceptable Type I error (a), together with the standard deviation, S_{net}, of the net signal when the net signal equals zero, establish the Critical Level, L_c, upon which decisions may be based.

Operationally, an observed signal, S, must exceed L_c to yield the decision, detected.

$$L_c = k_a s_b (1+T_b/T_s)^{0.5}$$

Where:

k_a is related to the standardized normal distribution and corresponds to a probability level of 1-a. For instance, selection of a = 0.01 corresponds to a 99% confidence level that activity is present. When determining the L_c for different measurement processes, it is allowable to set a at less than or equal to 0.05 as long as the following condition is met:

To set a for L_c determination at less than 0.05, the equation for the LLD (which places a less than or equal to 0.05) should be employed to verify that the calculated LLD is less than or equal to the LLDs specified in the IP-3 RETS. This calculation, if necessary, will be performed on a case by case basis.